NEPAL ELECTRICITY AUTHORITY

(An Undertaking of Government of Nepal)
Project Management Directorate

CHOBHAR PATAN CHAPAGAUN 132 kV UNDERGROUND TRANSMISSION LINE PROJECT

A component of
Electricity Grid Modernization Project

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of New Patan 132/11kV GIS Substation (Package A1.2)

(Procurement of Plant)

Single-Stage, Two-Envelope
Bidding Procedure

Issued on:	**5 July, 2023**
Invitation for Bids No.:	**PMD/EGMPAF/CPCUGTLP-079/80-01**
OCB No.:	**PMD/EGMPAF/CPCUGTLP-079/80-01**
Employer:	**Nepal Electricity Authority**
Country:	**Nepal**

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CHAPTER 1 – PROJECT SPECIFICATION REQUIREMENT (PSR)

FOR

New Patan 132/66/11 kV GIS Substation

CHAPTER 1-Project Specification Requirement

1. GENERAL

Nepal Electricity Authority is intending to upgrade existing New Patan Substation into 132/66/11kV Gas Insulated substation at Lagankhel, Lalitpur. It will be connected to Chobhar Substation (under construction) at 132 kV level. Existing New Patan Substation is connected to Baneshwor Substation and Siuchatar Substation at 66 kV level.

The project for construction of New Patan Substation 132/66/11kV GIS substation is being funded by ADB under the Chobhar Patan Chapagaun 132 kV Underground Transmission Line Project of Electricity Grid Modernization Project Additional Financing (EGMP-AF).

This specification describes the requirements for construction of the substations on a turnkey basis.

New Patan Substation site is existing 66/11 kV Substation Facility of NEA.

2. INTENT OF SPECIFICATION

The specification includes design, engineering, manufacture, fabrication, testing at manufacturers works, delivery, unloading at site, storage, erection, testing and commissioning at site including civil works. It is the intent of this specification to describe primary features, materials, design & performance requirements and to establish minimum standards for the work.

Patan Substation

The complete 132kV indoor SF6 gas insulated metal enclosed switchgear (GIS), 132/11 kV, Three (3) sets of 45MVA 3 phase Transformer, 132/66 kV Two (2) sets of 63 MVA 3 phase Transformer, associated civil works, internal roads, drains, trenches necessary switchyard buildings etc, 132kV GIS ducts/cables to be laid in trenches, cable terminations, Control & protection and upgradation/integration/ modification of Substation Automation System(SAS) and visual monitoring system with current scope of new SAS & visual monitoring system to be built under this package, FO based communication system and, other electrical and mechanical auxiliary systems, Fire Fighting Systems and construction of GIS cum Control buildings other associated civil works, internal roads, drains, trenches, switchyard buildings etc., on turnkey basis. The new 132 kV GIS system shall be interconnected to existing 66 kV switchyard through 132/66 kV transformer. All necessary works for commissioning the substation are in the scope. Also the 11 kV side of transformers shall also be connected with existing 11 kV switchgear.

The specification is not intended to specify the complete details of various practices of manufactures/ bidders, but to specify the requirements with regard to performance, durability and satisfactory operation under the specified site conditions.

2.1 The detailed scope of work is brought out in subsequent clauses of this section.

Civil Works	External electrical Works	Transformers	Switchgear	Design and Integration
Substation Compound and access road. Transformer bays. Site Clearance and dismantling works.	All equipment necessary to connect the new GIS substation to the 132kV transmission line and connection with existing 66 kV AIS	132/11 kV, 45MVA Transformers 132/66 kV, 63 MVA Transformers With nitrogen based fire fighting system	132kV GIS & switchboard as described in the specification	The substation shall be designed by the contractor and shall follow NEA requirements.
132kV GIS and Switchgear Room				All equipment and protection shall be integrated by the contractor and commissioned in conjunction with requirements NEA.
Associated control rooms, battery room, AC/DC Switchboard room		Station Supply transformers 11/0.4kV,315 kVA	Necessary integration/modification/upgradation of 11 kV switchgear	
Other facilities required by NEA and described in the specification			Providing supply for 11 kV feeders	The substations shall be constructed as fully integrated turnkey packages.

3. SCOPE OF WORK

- **Upgradation work at 66 kV New Patan Substation(existing) with the provision of following bays as per Single Line Diagram and as indicated in BPS;**

  132 kV GIS Switchyard: 132 kV switching scheme will be double main bus (DM) type. Details of bays are as below:

  - 132 kV line bays: 6 (Six) numbers of line bays out of which 2 numbers for 132 kV Double Circuit Chobhar Patan Underground Transmission Line and 4 (Four) numbers for future use
  - 132kV Transformer bay: 3 (Three) numbers bay 132/11kV, 31.5/45 MVA 3-phase Outdoor transformers and 2 (Two) Nos bay of 132/66kV, 51.5/63MVA 3-Phase Outdoor Transformer.
  - Interconnection of 66 kV AIS with 132 kV GIS through ICT
  - 132 kV Bus coupler bay: 1 (one) number
  - 2 no of 132 kV Bus Voltage measurement PT and associated protections
- **Connection/upgradation/modification of existing MV Indoor Switchyard Panels required to complete the scope of work**

4. DETAILED SCOPE OF WORK

Detailed scope of work for each substation is brought out in subsequent clauses of this section:

Upgradation work at New Patan Substation

i. **145 kV GIS System:**

The 145kV SF6 gas insulated switch gear shall have double main bus bar arrangement. The Switchgear (50 Hz) shall be complete with all necessary terminal boxes, SF_6 gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment & piping and support structures along with base plate & foundation bolts for fixing the switchgear with raft foundations.

The SF6 gas insulated switchgear shall be of the indoor metal enclosed type. Quantity of GIS modules shall be as per BPS. Description of **each type of GIS module** is as follows:

1. Set of three phase, **2000A, 31.5kA for 1 Sec**, SF_6 gas-insulated metal enclosed **bus bar module,** each comprising of :

   i) Bus bars enclosures running across the length of the switch gear to inter connect each of the circuit breaker bay modules in double main bus system & in future to interconnect two spare bay modules in double main bus system.

   ii) Three (3) nos. 1-phase or 1 no of 3 phase, as applicable inductive potential transformers, complete with isolator switch suitable for double bus arrangement.

   iii) One (1) no. 3-phase, group operated safety grounding switch, complete with manual and motor driven operating mechanisms.

   iv) Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required.

   v) Local Control Cubicle (if required separately)

   vi) End Piece with the test link for Future extension of Bus bar module. As 145kV GIS is likely to be extended in future, the contractor shall make available all details such as cross section, gas pressure etc. required to design adopted in future for extension of GIS, during detailed engineering stage. The end piece module may be designed in such a way that future GIS module may be tested without extending Voltage to existing bus by removing the test link.

2. 145kV, 31.5KA for 1 second, SF6 gas-insulated metal enclosed **Bus-Coupler bay module** comprising of:-

   vii) One (1) **2000A, 31.5kA,** 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.

   viii) Three (3) Nos. 1 Phase or 1 no of 3 phase, as applicable, 5-core, multi ratio, Current Transformers duly distributed on both sides of Circuit Breaker.

   ix) Two (2) nos. 3-phase, 2000A, 31.5kA group operated isolator switches, complete with manual and motor driven operating mechanisms.

   x) Two (2) nos. 3-phases, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

   xi) Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge Measurement Sensors etc. as required

   xii) Local Bay Control Cubicle

3. 145kV, 31.5KA for 1 second, SF6 gas-insulated metal enclosed Line feeder bay module suitable for cable termination with each set comprising of :-

   i) One(1) no. **1600A, 31.5kA**, 3-phase, SF_6 insulated circuit breaker,

complete with operating mechanism.

ii) One (1) or Three (3) nos. of 3 Phase or 1-phase, as applicable, 5-core, multi ratio, current transformers duly distributed on both side of Circuit Breaker.

iii) Three(3) nos. 3-phase, 1600A, 31.5kA group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv) One (1) or Three (3) nos. of 3 Phase or 1-phase, as applicable, potential transformers.

v) Two (2) nos. 3-phases, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

vi) One (1) no. 3-phase, high speed fault make grounding switch, complete with group operated manual and motor driven operating mechanisms.

vii) One (1) or Three (3) nos. of 3 Phase or 1-phase, as applicable, Lightning arrestors.

viii) SF6 ducts inside GIS hall if required (up to the outer edge of wall)

ix) Gas monitoring devices, barriers, pressure switches UHF based Partial Discharge Measurement Sensors etc as required.

x) Local Bay Control Cubicle

4. 145 kV, 31.5kA for 1 sec, SF6 gas insulated **ICT feeder bay module** each comprising of (for three phase transformer):-

i) One (1) no. **1250 A, 31.5kA**, 3-phase, SF_6 gas insulated circuit breaker, complete with operating mechanism.

ii) One (1) or Three (3) nos. of 3 Phase or 1-phase, as applicable, 5-core, multi ratio, current transformers duly distributed on both sides of Circuit Breaker.

iii) Three (3) nos. 3-phase, 1250A, 31.5kA group operated isolator switches complete with manual and motor driven operating mechanisms.

iv) Three (3) nos. 3-phases, group operated safety grounding switches complete with manual and motor driven operating mechanisms.

v) One (1) or Three (3) nos. of 3 Phase or 1-phase, as applicable, Lightning arrestors (if required as per design)

vi) SF6 ducts inside GIS hall, if required (up to the outer edge of wall)

vii)Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required.

viii)Local Bay control cubicle

5. **Gas Insulated Bus (GIB) ducts : (if required)**
145kV, 1600/1250A, 31.5kA for 1Sec, **SF6 Gas insulated Bus Duct** (GIB) for Line/Transformer feeder modules outside GIS hall (i.e. wall surface) with support structure (along with Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required) and SF6/Air bushing for interconnecting it with respective over head gantry/ equipment. SF6 gas ducts, where required inside GIS hall are part of GIS module.

6. **145kV Gas Insulated SF6 to Air Termination:-(if required)**

- 145kV, 1600/1250A, 1-phase SF_6 to air bushings for outdoor overhead connections. The cantilever strength of the 145kV SF_6 to air bushings shall be of minimum 8kN.

A tentative layout / GA drawing of the switchyard is enclosed with this specification for 132/66/11kV Substation. The GIB duct length shall be optimized further without affecting the switchyard arrangement and bay orientation and also any of the functional requirements specified.

7. **Testing & Maintenance Equipments as per BPS(Bid Price Schedule)**
8. **Mandatory Spares as per (BPS)**
9. **Any other equipment/material required to complete the specified GIS scope of work.**

ii. **Air Insulated Switchgear (AIS) and other main equipments**

1. Three(3) nos of 31.5/45 MVA, 132/11kV, 3-Phase outdoor Power Transformers with Nitrogen Injection Fire Protection cum extinguishing System (NIFPES)including all materials / fittings / accessories/surge protection device/bushing CT/Digital RTCC panel/ MB/Cables including special cable (if any),etc.

2. Two (2) nos of 51.5/63 MVA, 132/66kV, 3-Phase outdoor Power Transformers with Nitrogen Injection Fire Protection cum extinguishing System (NIFPES) including all materials / fittings / accessories/ surge protection device /bushing CT/Digital RTCC panel/ MB/Cables including special cable (if any),etc.

3. DGA suitable for detecting 8 gases shall also be included in Power Transformer. Similarly, it shall be communicable and connected to existing SAS system.

4. Integration/upgradation/modification of existing Sub-station automation system (SAS) with new SAS under this scope including complete hardware and software along with associated equipment for 132kV, 66 kV & 11 kV bays as per Single line diagram (bay as defined in Technical Specification, Section - Substation Automation). The new SAS system in this scope of work shall be interconnected with existing under construction SAS system at New Patan so that the data/operation can be performed from single location. Further, the contractor shall also supply necessary BCUs for monitoring & control of Auxiliary system. SAS panels required shall be placed in control room. Further, the automation system for all bays shall have provision for future integration of one (1) number of protection IEDs per feeder bays.

5. Complete relay and protection system as per section –Control and Relay panels including Bus Bar Protection for 132 kV Double Bus Bar Switching Scheme. The protection to be provided on 132 kV lines shall be as under;

Main-I Protection shall be Directional differential/distance protection scheme as per specification of section control and Relay panels compatible with protection system installed at relevant substations for line. If Main Protection relay is to be provided by another project team, its installation/testing/commissioning shall be the responsibility of the bidder and its price shall be included respectively. Backup Protection shall be Over current / Earth Fault based protection system. Similarly, for the protection of 132/66 kV transformer, existing 66/11 kV transformer protection panel shall be replaced with the new 132/66 kV protection panels. Dismantling of existing panel with accessories, storage and handover is responsibility of the contractor. The cost for such works shall be included in bid prices elsewhere in price schedule and no separate payment will be made for such works.

6. Two (2) no. 315 kVA, 11/0.400 kV, LT Transformers along with associated 11

kV equipments. It shall be located near the existing station transformer and HT side shall be connected with the 11 kV bay in the Indoor Switchgear through 11 kV cable and LT to the respective places. The existing LT transformer shall be removed and handed over to NEA. All connection of existing LT transformer shall be replaced by new 315 kVA transformer. All mentioned above is the responsibility of the Contractor and its price shall be included in LT transformer section.

7. Connection/Upgradation/Modification of existing MV Indoor Switchgear; its price shall be included in LT transformer section.

8. Lattice or pipe structures (galvanized): Lightning Masts(LM), Equipment support structures, New Gantry Structures if required, Dismantling/upgradation/modification of existing 66 kV gantry structure if required and other necessary structures including foundation to complete the scope of work.

9. Any communication structure/electric poles/cables/drainage system/other any structures inside the substation layout that is required to be shifted shall be the scope of the Contractor and its price be loaded in respective section. There shall be minimum outage during shifting with proper planning with alternative ways for minimizing the outage and it shall be functioning as previously. The cost for such works shall be included in bid prices elsewhere in price schedule and no separate payment will be made for such works. All dismantled metal works shall be stored at designated place by the Engineer and handover to the relevant authority.

10. Surge Arresters and Bus Post Insulators as per BPS

11. Complete Fire Protection System suitable for electrical fire protection of outdoor transformer, GIS at Patan Substation and all buildings. The fire fighting system shall be designed and implemented for power transformers considering space constraint. NIFPES is envisaged for power transformers.

12. Air Conditioning System in Control/monitoring room cum administrative building and necessary relevant places.

13. Ventillation Systems for GIS hall and necessary places

14. 132 kV XLPE cable termination/connection shall be provided as per design and drawings to be developed by the Contractor. Similarly, 132 kV Lightning Arrestors (AIS) if required as per design requirement shall be used. 66 kV of 132/66 kV transformer shall be connected to existing AIS system directly through 66 kV Lightning arrestor if required. Existing 66 kV Lightning Arrestors shall be stored and handed over to NEA safely with required dismantling without any extra cost to the Employer. New 66 kV Lightning Arrestors shall be installed at required location for protection of power transformer of 132/66 kV.

15. Bus post Insulators, insulator strings and hardware, clamps & connectors, spacers, Aluminum tube, conductor, Earth wire, Bus bar and earthing materials, Auxiliary earth mat, Bay marshalling box, cable supporting angles/channels, Cable trays and covers, Junction box, buried cable trenches for lighting, PVC pipes for cabling of equipment etc. as per requirement.

16. LT switchgear (AC/DC Distribution boards) considering present bays and future bays including insulating Mats.

17. 125 KVA Silent type outdoor DG Set with acoustic enclosure.

18. Batteries & Battery Chargers. 2 sets of battery charger for 1 set of battery shall be designed to be in redundant mode, while one is working other shall be in standby mode.

19. 1.1 kV grade Power & Control cables along with complete accessories, including Cable for oil filtration units.

20. 12kV HT cable along with jointing Kit and other accessories for connection of

LT Transformers and interconnection of LV side of 132/11 kV Transformer to Indoor LT Panel.

21. 132 kV cables with necessary straight through joints, all accessories, termination arrangement for connection between GIS and Transformer

22. Complete indoor & outdoor lighting and illumination of the switchyard including DG set area, street lighting, GIS Buildings, Control Room cum administrative Building and all other necessary places etc.

23. Complete Earth mat inside the GIS building and outdoor yard. Earthing of all outdoor equipments including Transformers. Measurement of earth resistivity is in the scope of Contractor.

24. Cranes for GIS Hall

25. The specification of Digital Protection coupler (if required) is attached as Annexure-III.

26. FOTS based Telecommunication system

27. Any other equipment/material required for completing the specified scope, shall be included in the scope of supply and the offer should be complete & comprehensive. Design, engineering, manufacture, testing, supply including transportation, insurance & storage at site of **mandatory spare**s as per **Annexure-I**

iii. **Civil works - The scope of work shall include but shall not be limited to the following based on design and drawings to be developed by the contractor**

The soil investigation is in the Contractor's Scope. Therefore, the contractor is required to design and implement the works as per soil investigation report.

1. Drawings of Master/General Layout Plan, has been prepared. Employer will provide such drawings for reference only. The bidder shall design considering space constraint.
2. Foundation of 132/11 kV, 132/66 kV Transformers along with jacking pads, rail track, Oil soak pit, sump pit, pylon support and fire resistant wall (s) as required.
1. Construction of 132kV GIS room/control room/switchgear buildings:
2. Foundation for structures of LM, LA, 132kV/66kV XLPE cable termination, equipment support structures, gantry structures and other equipment's after dismantling the existing foundation of unused structures..
3. Foundation for Auxiliary LT transformers, DG set
4. Cable trenches inside and outside control room building and GIS hall building along with covers and sump pits. The cable trench layout shall be prepared by the contractor.
5. Cable trench crossings with roads, rail tracks, drains, etc.
6. Switch yard Roads: All roads shall be RCC Roads as shown in GA drawing including culverts.
7. Strengthening of approach road: Strengthening / repair of approach road/ bridges, if required during transportation of equipment and materials, shall be included in respective item of price schedule. Employer will not be liable for any additional payment for such work.
8. Antiweed treatment, PCC(1:5:10) and Stone spreading in the switchyard area. Layout detail drawings shall be developed by the contractor.
9. Switch yard Chain link fencing and gates.

10. Contouring and site leveling: The leveling in the area under the scope of work inside substation boundary wall is to be carried out to achieve finished ground level. The leveling area and finished ground level shall be decided during detail engineering stage. The cost for such works shall be included in bid prices elsewhere in price schedule and no separate payment will be made for such works.
11. Construction of random rubble stone masonry wall and gabion wall (if required).
12. Drain and culverts, Drain Layout shall be developed by the contractor based on various type of drains. Existing old drainage system beneath the ground shall be noted and necessary shifting may be carried out without causing any damage on it and it shall function as previously. The cost for such works shall be included in bid prices elsewhere in price schedule and no separate payment will be made for such works.
13. Boundary wall along substation property line and main gate
14. GIS Buildings including control room cum administrative building. The GIS hall shall be suitable for mounting of EOT crane. The control room building shall be RCC structure following Nepalese architectural design (Refer tender drawings i.e. architectural drawing) and GIS Hall shall be Pre-Engineered steel structure as per Section "Civil".
15. All civil works including foundations associated with erection of SF6 gas insulated metal enclosed switchgear along with its SF6 ducts inside the building.
16. Foundation for SF6 duct supporting structures (outside building), SF6/Air bushings. Foundation loads for GIS bus duct supports (Vertical, shear and moment) shall be provided with detailed calculation.
17. Cable trenches inside/outside GIS building & control room cum administrative building.
18. External water supply arrangement for control room cum administrative building,
19. External sewerage system for control room cum administrative building.
20. Foundation for lighting poles, panels and control cubicles of equipments wherever required
21. Dismantling and disposal of existing fencing walls, Dismantling/Removing of existing structures, foundation, equipment etc., if required, shall be included with the bid prices elsewhere in the price schedule and no separate payment will be made for such works.
22. Dismantling and removal of 66/11kV Power transformer and associated accessories/structures. Its cost shall be included with the installation cost of 132/66 kV transformer in same place. The transformers required for removal shall be handed and transported over to relevant authority at place within Kathmandu Valley designated by the Engineer in good condition. Dismantling of other existing equipment, if required, shall be included with the bid prices elsewhere in the price schedule. Any structures, equipment, materials required for commissioning of 132/66 kV transformer successfully shall be loaded in individual item.
23. General Soil investigation has been carried out. NEA will provide Geotechnical Investigation Report of the substation area for reference. However, contractor shall carry out required Soil investigation(tests) for confirmation. The cost for such test shall be included in respective item in price schedule.
24. Pumps: Dewatering Pumps, booster pump for underground water tank

as per design.(if required)

25. The technical specification for external finishing of control room building and roofing has been included in Annexure included in Chapter 14 and external finishing and roofing shall be decided during detail engineering design.
26. Doors and windows of front face shall be wooden(carved). TS for door and windows has been attached in Annexure of chapter 14 and in tender drawings.
27. Any other item/design/drawing for completion of scope of works.

iv. **Modifications/Dismantling Works at Patan Substation**

a) At Patan substation, the Employer intends to dismantle the existing civil structures (as marked in GA layout which might be necessary for construction of Substation), felling, logging of marked trees including roots if necessary, Debarking of logs, transportation to specified log yard, piling, stacking of firewood for construction of 132 kV GIS Substation. The entire area thus vacated shall be levelled and be made ready for current scope of work. The bidder shall consider salvage value of dismantled civil structures(excluding crane & its metal support structures which shall be transported/handover over to NEA at designated place by Engineer) during the bid and quote accordingly. The cost for such works shall be included in bid prices and no separate payment will be made for such works.

b) The bidders are advised to visit the substation sites and acquaint themselves with the topography, infrastructure and also the design philosophy. Before proceeding with the construction work of the new Sub-stations and existing substations, the Contractor shall fully familiarize himself with the site conditions and General arrangements & scheme etc. Though the consultant/NEA shall endeavor to provide the information, it shall not be binding for the consultant/NEA to provide the same. The bidder shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the construction and successful commissioning, operation & maintenance of the substation in all respects. All materials required for the Civil and construction/installation work shall be supplied by the Contractor. The cement and steel shall also be supplied by the Contractor. The complete design (unless specified otherwise in specification elsewhere) and detailed engineering shall be done by the Contractor based on conceptual tender drawings. Drawings for civil works enclosed with tender drawings are for information only. However civil drawings shall be developed by the contractor as per his design.

b. The Contractor shall also be responsible for the overall co-ordination with internal/external agencies; Supplier of Owner's supplied equipments, project management, training of Owner's manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the substation/switchyard.

c. Design of substation and its associated electrical & mechanical auxiliaries systems includes preparation of single line diagrams and electrical layouts including layout arrangement for transformers, foundation layout, cable trench layout, earthmat layout, erection key diagrams, electrical and physical clearance diagrams, design calculations for earthing and lightening protection system (including Direct Stroke Lighting Protection), control and protection schematics, wiring and termination schedules, civil designs and drawings, design of fire fighting system and air conditioning system, indoor/outdoor lighting/illumination and other relevant drawings & documents required for engineering of all facilities within the fencing to be provided under this contract, are covered under the scope of the Contractor.

d. Any other items not specifically mentioned in the specification but which are required for erection, testing and commissioning and satisfactory operation of

the substation are deemed to be included in the scope of the specification unless specifically excluded.

e. The cost for dismantling, removal and storage of existing equipments necessary for installation of new equipment & structure, and breakage / dismantling of existing structures etc required for successful completion of the project shall be included in the bid prices of the equipment. No extra cost will be paid.

f. The technical specification for various equipments and works for different voltage levels have been standardized. Items, which are not applicable for the scope of this package as per schedule of quantities described in BPS, the technical specification for such items should not be referred to.

EXCLUSIONS

Employer's site office.

2. PHYSICAL AND OTHER PARAMETERS

Location of the Substations –

- New Patan Substation is located in Lalitpur located 4.5 km far from the Baneshwor Substation.

Altitude above sea level : 1420m from MSL

Ambient Air Temperature : 45ºC(max)/ 0 ºC(min)

Average Humidity (in %): 95 (max), 40(min)

The substation locations are lying in the wind speed Zone 4 i.e. 47m/s.
Seismic Requirement for Substations equipment: 0.5g (Horizontal peak acceleration value).

Seismic Requirement for Substations civil structure: Minimum value of 0.36g (Horizontal peak acceleration value). The contractor shall provide the justification for use of above value during DDE.

However, for design purposes, ambient temperature should be considered as 50 degree centigrade and Relative humidity 100% for the substation.

The fault level of all equipment to be supplied under present scope shall be as indicated below:

S.NO.	Voltage Level	Fault Level
1	220kV	40 kA for 1 Sec
2	132kV	31.5kA for 1 Sec
3	66kV	31.5kA for 1 Sec
4	11kV	25kA for 3 Sec

3. SCHEDULE OF QUANTITIES

The requirement of various items/equipments and civil works are indicated in Bid price Schedules.
All equipments/items and civil works for which bill of quantity has been indicated in BPS (Bid price Schedules) shall be payable on unit rate basis/quoted rate basis. During actual execution, any variation in such quantities shall be payable as per relevant clauses incorporated in Letter of award.

Wherever the quantities of items/works are not indicated, the bidder is required to estimate the quantity required for entire execution and completion of works and incorporate their price in respective Bid price schedules. For erection hardware items, Bidders shall estimate the total requirement of the works and indicate module-wise lump sum price bay wise and include the same in relevant Bid price schedules. For module identification, Bidder may refer typical drawings enclosed with the specifications. Any material/works for the modules not specifically mentioned in the description in BPS, as may be required shall be deemed to be included in the module itself.

The detailed bill of quantities of the mandatory spares for which break up is not given in the bid price Schedules are indicated at **Annexure-1.I** of this part.

Bidder should include all such items in the bid proposal sheets, which are not specifically mentioned but are essential for the execution of the contract. Item which explicitly may not appear in various schedules and required for successful commissioning of substation shall be included in the bid price and shall be provided at no extra cost to Owner.

4. BASIC REFERENCE DRAWINGS

5.1 Single line diagram and general arrangements are enclosed with the bid documents for reference, which shall be further engineered by the bidder.

5.2 The reference drawings, which form a part of the specifications, are given at **Annexure-I**. The bidder shall maintain the overall dimensions of the substation, phase to earth clearance, phase to phase clearance and sectional clearances.

5.3 The enclosed drawings give the basic scheme, layout of substation, substation buildings, associated services etc. In case of any discrepancy between the drawings and text of specification, the requirements of text shall prevail in general. However, the Bidder is advised to get these clarified from Owner.

5.4 The auxiliary transformers shall be used to feed the substation auxiliaries. HT side of auxiliary transformer shall be connected through 11 kV HT cable to LT Panel. These auxiliary transformers should not be used for construction purpose. The detailed scheme is shown in the single line diagram.

5. ORDER OF PRECEDENCE OF DIFFERENT PARTS OF TECHNICAL SPECIFICATION

For the purpose of present scope of work, technical specification shall consist of following parts and they should be read in conjunction with each other.

1)	Chapter 1 : Project Specification Requirement	Rev 00
2)	Chapter 2 : General Technical Requirement	Rev 00
3)	Chapter 3 : Switchgear	Rev00
4)	Chapter 4 : LT Switchgear	Rev.00
5)	Chapter 5 : Battery & Battery Charger	Rev.00
6)	Chapter 6 : Lighting System	Rev.00
7)	Chapter 7 : LT Transformer	Rev.00
8)	Chapter 8 : Fire Protection System	Rev.00
9)	Chapter 9 : Power & Control Cable	Rev.00
10)	Chapter 10 : Air Conditioning System	Rev.00
11)	Chapter 11 : DG Set	Rev.00
12)	Chapter 12 : Switchyard Erection	Rev.00
13)	Chapter 13 : Structure	Rev.00

14)	Chapter 14: Civil Works	Rev.00
15)	Chapter 15 : Control & Relay Panels	Rev.00
16)	Chapter 16 : PLCC	Rev.00
17)	Chapter 17 : Substation Automation System	Rev.00
18)	Chapter 18: Fibre Optics Based Communication Equipments	Rev.00
19)	Chapter-19 : GIS	Rev.00
20)	Chapter-20-Transformer	Rev.00
21	Chapter 21-Indoor Switchyard Equipment	Rev 00
22	Chapter 22- EHV Cable	Rev 00
23	Chapter 23- Technical Data sheet	Rev 00

In case of any discrepancy between Chapter 1-PSR, Chapter 2-GTR and other technical specifications on scope of works, Chapter 1-PSR shall prevail over all other chapters.
In case of any discrepancy between Chapter 2-GTR and individual chapters for various equipments, requirement of individual equipment chapter shall prevail.

6. SPARES

Mandatory spares

The Mandatory Spares shall be included in the bid proposal by the bidder. The prices of these spares shall be given by the Bidder in the relevant schedule of BPS and shall be considered for evaluation of bid. It shall not be binding on the Owner to procure all of these mandatory spares.
The bidder is clarified that no mandatory spares shall be used during the commissioning of the equipment. Any spares required for commissioning purpose shall be arranged by the Contractor. The unutilized spares if any brought for commissioning purpose shall be taken back by the contractor.

7. SPECIAL TOOLS AND TACKLES

The bidder shall include in his proposal the deployment of all special tools and tackles required for operation and maintenance of equipment. The special tools and tackles shall only cover items which are specifically required for the equipment offered and are proprietary in nature. However a list of all such devices should be indicated in the relevant schedule provided in the BPS. In addition to this the Contractor shall also furnish a list of special tools and tackles for the various equipment in a manner to be referred by the Employer during the operation of these equipment. The scope of special tools and tackles are to be decided during detail engineering and the list of special tools and tackles, if any shall be finalized.

8. FACILITIES TO BE PROVIDED BY THE OWNER

9.1 NEA shall make available the auxiliary HT power supply on chargeable basis at a single point in the Sub-station. The prevailing energy rates of the state shall be applicable. All further distribution from the same for construction and permanent auxiliary supply shall be made by the contractor. However, in case of failure of power due to any unavoidable circumstances, the contractor shall make his own necessary arrangements like diesel generator sets etc. at his own cost so that progress of work is not affected and NEA/Consultant shall in no case be responsible for any delay in works because of non-availability of power.

9.2 The contractor shall make his own arrangement at his own cost for

arranging water required for construction purpose. NEA/Consultant shall in no case be responsible for any delay in works because of non-availability or inadequate availability of water.

9. SPECIFIC REQUIREMENT

10.1 The Bidders are advised to visit Sub-stations site and acquaint themselves with the topography, infrastructure, etc.

10.2 The bidder shall be responsible for safety of human and equipment during the working. It will be the responsibility of the Contractor to co-ordinate and obtain Electrical Inspector's clearance before commissioning. Any additional items, modification due to observation of such statutory authorities shall be provided by the Contractor at no extra cost to the Owner.

The Contractor shall arrange all T&P (such as necessary supports, cranes, ladders, platforms etc.) for erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damages shall be to the account of contractor.

10.3 Augmentation and integration work related to SCADA System

The 132/66/11kV bays under present scope at the substations shall be integrated by the contractor into existing SCADA system of Siemens 'SINAUT Spectrum"(version 4.3.2) installed at Master Station i.e. Nepal Electricity Authority LDC, Load Dispatch Centre (located in Siuchatar, Kathmandu) and ECC (Emergency Control Center) at Hetauda. The integration shall include all hardware and software required at the Control Centre as well as necessary data base, display generation and upgrades for proposed control and monitoring of station and Network Analysis. The manufacturers of the existing SCADA system are:-
LDC/ECC facilities: Siemens Germany
SAS at Patan SS and MCC at Baneshwor SS: GE make

The existing communication protocol used for SCADA at LDC/ECC is IEC 101/104. For the present scope of work no RTU is envisaged and the Data for SCADA purpose shall be obtained from the Substation Automation System(based on IEC 61850) using redundant Gateway port with communication protocol IEC 101/104 as per requirement being provided under present contract.
The scope of work for supply, installation/upgradation/integration of Optical Line Termination Equipment, Digital Multiplexer, hardware accessories etc at substations, LDC Katmandu, ECC Hetauda and its integration work (at LDC Kathmandu, ECC Hetauda) for onward transmission of Data and Voice communication upto LDC/ECC is included in the contract.

i. One set ½C x 300 Sq. mm XLPE power cable for oil filtration units of transformers shall be provided along with 250Amps, TPN MCCB receptacles at Patan substation. The cable shall be terminated at 250A MCCB receptacle at one point near Transformer in the yard. The price shall be loaded under Power and Control Cable section of BoQ.

ii. In Chapter 2 GTR and other Technical specifications, the term "Purchaser" and/or "Employer" may be read as "Owner".

iii. Erection, testing and commissioning of GIS, Transformers, Substation automation system, Control and protection Panels & Communacation shall be done by the contractors under the supervision of respective equipment manufacturers. Charges for the above supervision shall be included by the bidder in the erection charges for the respective equipment in the BPS.

iv. The Contractor shall impart the necessary training to NEA's Personnel as per following details:-

1. **Training at Manufacturer's works**. The Contractor shall include in the training charges (i) Accomodation Charges (ii) payment of per Diem allowance to NEA trainees as per Financial TADA Byelaws of NEA per day per trainee for the duration of abroad towards meals and other incidental expenses and (iii) to and fro economy class air ticket from Nepal to place of training. The duration of training shall be excluding travelling period. It shall be quoted under Schedule 4(b):Training Charges for training to be imparted abroad.

   The training shall be provided in the field of design, testing and maintenance at Manufacturer's works as per following:-

   (a) Control & Protection and Substation Automation System: 5 Days. (3 Nos. Trainees or as per BPS)

   (b) GIS: 5 Days. (3 Nos Trainees or as per BPS)

   (c) Telecommunication Equipment (SDH, MUX & NMS (Craft Terminal)) and DPC: 5 Days. (3 Nos. Trainees or as per BPS)

   (d) Transformer: 5 Days. (3 Nos. Trainees or as per BPS)

2. **On Job Training in Nepal:** The traveling and living expenses of Owner's personnel for the training programme conducted in Nepal shall be borne by the Owner. The contractor shall bear the per diem expense @ NRs. 1000.00 per person/day who are nominated for the training. It shall be quoted under Schedule 4(c):Training Charges imparted to Employer's Personnel by Bidder's Instructor in Nepal.

   The training shall be provided to Employer's personnel in the field of erection, testing, operation and maintenance at substation sites respectively as per following:-

   (a) Control & Protection: 5 Days. or as per BPS
   (b) Substation Automation System including integration aspect of existing SCADA (of Siemens supplied SINAUT spectrum) at Load Dispatch Centre: 5 days. or as per BPS
   (c) GIS: 5 days. or as per BPS
   (d) Telecommunication Equipment (SDH, MUX & NMS (Craft Terminal)) and DPC: 5 Days or as per BPS
   (e) Transformers - 5 days or as per BPS

v. The lighting fixtures for switchyard lighting shall be mounted on LMs wherever LMs are provided. Where LMs are not available, the fixtures may be mounted on Gantry structures or on lighting poles to be provided by the contractor.

vi. All RCC shall be of M-25 grade (Minimum) with mixed design conforming to relevant international standard/BS. All Reinforcement steel shall be of FE-500(Minimum) grade conforming to International standards /BS.

   (a) The Frequency range for the earthquake spectra shall be as per IEC-62271-300 for Circuit Breaker.

(b) One number each Energy meter for the record and revenue purpose is to be provided for each 132/66/11kV bays (Bus coupler bays to be excluded) at Patan SubStation under present scope of contract, meeting the requirement as specified at **Annexure – V**.

(c) The reference of IS standard (i.e. Indian Standard) mentioned in the technical specification shall be read as equivalent IEC or BS or equivalent International Standard.

vii. Non CFC refrigerant shall be utilized for Air conditioning system

viii. Nuts, Bolts and washers for all non standard structures shall be payable as per BPS.

ix. The switchyard panel room as detailed in section Sub-station Automation System is not required for GIS station. The contractor shall place their panels i.e. Bay level units, relay and protection panels, Digital RTCC panels, DPC panels etc. for 132kV & 66 kV in respective GIS hall(s). The room shall be air-conditioned and the supplier shall submit detailed heat load calculation during detailed engineering. Further, the temperature of enclosure /room shall be monitored through substation automation system by providing necessary temperature transducers.

x. In the Sub-station automation system, each gas tight GIS compartments shall be monitored individually per phase basis, as applicable. In case it is not possible to monitor the gas tight compartment individually, the contractor shall supply additional BCU without any additional cost implication to Owner.

xi. The price of Bus-duct inside the GIS hall shall be integral part of the respective bay module and it will not be paid separately. However, the payment of bus-duct for outside the GIS hall along with support structure shall be paid as per running meters in line with provision of Bid Price schedule. Therefore, bidder is required to quote for 132kV GIB (SF6 Gas insulated Bus Duct) of Line/Transformer feeder module required outside GIS hall with support structure and SF6/Air bushing for interconnecting with its respective gantry / equipment (Overhead connection) separately as per provision of Bid price schedule.

xii. The Contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities for the transportation of the equipment. The dimension of the equipment shall be such that when packed for transportation, it will comply with the requirements of loading and clearance restrictions for the selected route. It shall be the responsibility of the contractor to coordinate the arrangement for transportation of the transformers & reactors for all the stages from the manufacturer's work to site.

xiii. The conditions of roads, capacity of bridges, culverts etc. in the route shall also be assessed by the bidders. The scope of any necessary modification/ extension/ improvement to existing road, bridges, culverts etc. shall be included in the scope of the bidder, without any extra cost to NEA (If not mentioned specifically in the BPS). The contractor shall carry out the route survey along with the transporter and submit the detail proposal and methodology for transportation of transformers & reactors within three months from the date of award.

xiv. The specification of PABX is attached at Annexure-**VI**.

xv. Specification of 11 kV outdoor equipment's is attached at **Annexure-VII**

11. PRECOMMISSIONING, COMMISSIONING, TRIAL-RUN & COMPLETION

As soon as the Facilities covered by these specifications are physically completed in all respects, the Pre commissioning, Commissioning, Trial-run and

Completion of the Facilities, as mentioned below, shall be attained in accordance with the procedure given in the Conditions of Contract, Vol.-I of the Bidding Documents.

(i) Pre commissioning**:** As per relevant Chapters

(ii) Commissioning : Charging of the Facilities at rated voltage

Further, wherever appearing in these specifications, the words – 'commissioning checks', 'installation checks', 'site tests', 'performance guarantee tests for fire protection system', are to be considered as 'pre commissioning checks'.

(iii) Trial-run: Operation of the Facilities or any part thereof by the Contractor immediately after the Commissioning for a continuous period of 72(Seventy two) hours continuously. In case of interruption due to problem / failure in the respective equipment, the contractor shall rectify the problem and after rectification, continuous 72(Seventy two) hours period start after such rectification.

(iv) Completion : Upon successful completion of Trial-run.

'Guarantee Test(s)' and/or 'Functional Guarantees' are applicable only for Substation Automation System as specified in Chapter-'Substation Automation System.'

a) Social Safeguard and Environment and Management Plan

The Contractor shall prepare Social Safeguard and Environment Management Plan to be implemented during execution of the Project. The following major activities shall be considered:

Labour recruitment: The Contractor shall give preference to the use of local and regional labour provided that it is consistent with the requirement of good workmanship based on the need of the project.

Staff training and sensitization: At the beginning of works the Contractor shall organize training and awareness-raising workshops intended for his teams to improve their understanding to prevent or minimize the impact of their activities on the environmental and social aspects to promote good relations with the local people.

Among others topics addressed should also include the following:

Likely environmental impact of works, good practices, preventive and corrective measures to be adopted; Rules and procedures for waste management at construction sites; Safety risks associated with the works, and preventive attitude to adopt; First aid and what to do in case of accident; General standards concerning relations with the local people; Risks and prevention of sexually transmitted diseases. The training and awareness sessions should be organized whenever new workers are recruited. Feedback and training during the works and after the monitoring and control exercise, additional training and awareness activities may be necessary if it happens that the previous sessions had failed to achieve the desired effects.

Demarcation, signing and closing of worksites: Setting up warning signs at worksites to limit the access of persons, machinery and equipment into construction areas and confine the works related to the construction process to the allocated areas.

Access to private property: Contractor shall coordinate with the Employer for the access of private property, if required. Crossing of private property shall be subject to prior notification to the owners and conducted in such a manner as to minimize damage to crops or other property on the land.

Discovery of relics of historical and archaeological importance: In the unlikely event of discovery of historical relics, the works will be interrupted temporarily and the discovery notified to the local authority responsible for cultural heritage in order to determine the appropriate course of action.

Restoration of sites: After the infrastructure has been put in place and the construction sites and equipment depots cleared, the sites should be rehabilitated without undue delay in the original condition or better, unless there are plans for future use requiring that such sites be left in their current state.

Storage and handling of hazardous substances: Hazardous substances such as oils, lubricants or other hazardous substances likely to contaminate surface or ground water and soil should be stored or handled in premises specially designed for this purpose, in order to protect the environment and human health. If the handling of oils and fuels is necessary, demarcated and waterproofed areas that may contain any spills must be provided.

Maintenance of equipment: Maintenance of equipment should not be performed immediately at the work site as far as practicable.

Air quality and noise pollution: Care must be taken to ensure that all equipment, machinery and vehicles used for works and equipped with a combustion engine are in good working conditions to limit undesired emission of air pollutants and noise nuisance.

Construction works that could cause noise should be performed only outside normal rest hours near residential areas. When noisy works must be carried out close to schools or other noise-sensitive receptors, working hours should be so scheduled as to limit the nuisance caused.

It is forbidden to burn in the open any kind of household, industrial and toxic or hazardous waste, project induced waste and all types of scrap metal.

Transportation of equipment: Equipment for overhead lines will be transported by existing roads up to the point nearest to the installation site. Thereafter, it will be transported manually to the site without opening up any access paths. When crossing the land between roads and installation sites, care should be taken not to damage vegetation, agricultural land or any other property on the land.

Erection of Poles: Vegetation should be removed only in so far as strictly necessary for opening foundations for poles and for such other operations as may be performed at each spot.

When erecting the poles, necessary precaution should be taken to minimize the impact on adjacent areas.

Unrolling of cables: When cables are being unrolled, necessary precaution should be taken to prevent impact on tree vegetation, crops and other property on the land crossed by the cables. If necessary, temporary gantry-like structures should be used to facilitate crossings.

Restoration or damage compensation: If the works on private property cause damage to crops or other property, the Contractor must proceed with the repair of such damage or, where this solution is not sustainable, with the fair and timely compensation of the owners.

Management of material from digging trenches: Uncontaminated soil from excavations will be reused to backfill the trenches of underground lines. Any such soil that cannot be reused is deemed to be waste and must be conveyed to its final destination. Its uncontrolled spread is prohibited in places where it could cause damage. Minimum dust on ground policy is to be used to prevent dust associated pollution after the construction.

Sensitive Areas: From an environmental point of view, wetlands, swamps, and bogs should be avoided when planning underground cable as these habitats may suffer severe or even irreparable harm. Also sensitive water flows and archaeological sites should factor in route planning process.

Disruption of pedestrian and automobile traffic: When trenches are opened along the road, they should be barricaded, fenced off and warning signs placed at the worksites to ensure the safety of pedestrians, motorists and the staff carrying out the works.

There must be continued access to land and buildings located along trenches through installation of secure and clearly signalled temporary structures. This also applies to trenches that cut across the roadways. Upon completion of the underground cable installation, the trenches should be resealed and the pavement repaired as soon as possible, to ensure its durability and the absence of irregularities that may present a traffic hazard.

Regular sprinkling of water shall be done to avoid dust pollution till the roads/sidewalks are

reinstated.

Public information on electrical hazards, behaviour and preventive measures: Before switching on the infrastructure installed as part of the project, the neighbouring populations should be informed in good time, through public meetings and/or distribution of information leaflets. The information provided to them should focus on the electrical hazards associated with the infrastructure and the behaviour that would allow them to avert such hazards. The population of these areas should be particularlytargeted.

Unanticipated Impacts identified during the construction should be mitigated in coordination with environmental and social monitors employed by Contractor, Consultant and Government separately.

b) Safety of Personnel

The maximum safety consistent with good erection practices in the case of work above ground must be afforded to personnel directly engaged under this contract. Reasonable measures shall be taken to afford adequate protection against material falling from a higher level onto personnel below.

ANNEXURE- II

LIST OF PREFERED (SHORTLISTED) MAKE

It is preferred that the following equipment be supplied from the manufacturers listed hereunder:

a) **Main Protection Relays, Control &Relay panel, Substation Automation System from:** ABB, ALSTOM, SIEMENS, Fuji, Reyrolle, Toshiba, Mitsubishi, Hitachi, GE or equivalent.

b) **Energy Meters from:** ELSTER (ABB), ACTARIS (Schlumburger), EDMI, SIEMENS, AMETEK or equivalent.

c) **SF6 Circuit Breakers from:** ABB, ALSTOM, Hitachi, Siemens, Toshiba/Mitsubishi, LG, Fuji, GE or equivalent.

d) **VCB Switchgear from:** ABB, ALSTOM, Hitachi, Siemens, Toshiba/Mitsubishi, LG, Fuji, GE, Schnieder Electric or equivalent.

e) **On-Load Tap Changer:** The on-load tap-changer (OLTC) to be equipped on the power transformers and associated control equipment shall be from MR Germany or ABB Sweden or equivalent

f) **AVR:** The AVR to be equipped on the RTCC shall be from MR Germany or ABB Sweden or equivalent

g) **Temperature Indicators:** shall be from AB Khilstrom, Sweden or equivalent

h) **Gas Insulated Substation:** ABB, ALSTOM, SIEMENS, Toshiba / Mitsubishi, GE, HYOSUNG, Hyundai, Hitachi or equivalent.

i) **Communication System:** NOKIA, NOKIA SIEMENS, SIEMENS, ABB, AREVA/ALSTOM or equivalent

j) **Cable termination and joints:** ABB, Raychem, Hitachi, Brugg, 3M, Pfisterer or Equivalent

The bidders may offer equipment/brands other than those listed above that are better or equivalent with regard to quality and performance substantiated with appropriate documents. The bidder is required to submit all technical information, brochures, test reports of the proposed equipment for assessing equivalence with the shortlisted vendor during the bid submission.

Annexure III

SPECIFICATION FOR DIGITIAL PROTECTION COUPLER(if required)

1.0 Digital protection coupler for protection signalling through optical fibre cable system.

1.1 The Digital protection signalling equipment is required to transfer the trip commands from one end of the line to the other end in the shortest possible time with adequate security and dependability. It shall also monitor the healthiness of the link from one end to the other and give alarms in case of any abnormality. The protection signalling equipment shall have a proven operating record in similar application over EHV systems and shall operate on 48V DC (+10%, -10%). It shall provide minimum four commands. These commands shall be suitable for Direct tripping, Intertripping and Blocking protection schemes of EHV lines.

The protection signalling equipment shall communicate to the remote end interfacing with SDH terminal equipment at its 2Mbps port. It shall provide suitable interfaces for protective relays, which operate at 220/110V DC. Power supply points shall be immune to electromagnetic interface.

1.2 Principle of operation

During normal operation, protection signalling equipment shall transmit a guard signal/code. In case Protection signalling equipment is actuated by protective relays for transmission of commands, it shall interrupt the guard signal/code and shall transmit the command code to the remote end. The receiver shall recognize the command code and absence of the guard code and will generate the command to the protective relays.

All signal processing i.e. generation of tripping signal and the evaluation of the signals being received shall be performed completely digital using Digital Signal Processing techniques.

1.3 Loop testing

An automatic loop testing routine shall check the teleprotection channel. It shall also be possible to initiate a loop test manually at any station by pressing a button on the front of the equipment.

Internal test routine shall continuously monitor the availability of the protection signaling equipment.

Proper tripping signal shall always take the priority over the test procedure.

The high speed digital protection signalling equipment shall be designed and provided

with following features.

● Shall work in conjunction with SDH terminal equipment.

● It shall communicate on G 703 (E1,2 Mbps)

● Full Duplex operation

● Auto loop facility shall be provided

● Shall meet IEC 60834-1 standard

● Shall be able to transmit upto 4 commands with trip counter simultaneously or

sequentially in one 2Mbps channel

Bidder shall quote for protection signalling equipment suitable for 4 commands with

separate trip counters for transmit and receive. With regard to trip counters alternate

arrangement .i.e. Laptop along with software & all accessories to download events including carrier receipt and transmit shall be acceptable. Laptop for the above shall be supplied at each substation under substation package.

High security and dependability shall be ensured by the manufacturer. Probability of false tripping and failure to trip shall be minimum. Statistical curves/figures indicating above mentioned measures shall be submitted along with the bid.

The DPC can be either housed in offered Control & Protection Panel / PLCC Panel or in separate panel. Reports of the following tests as per clause 9.2 of Chapter 2-GTR shall be submitted for approval for protection signalling equipment and relays associated with the protection signalling equipment and interface unit with protective relay units, if any.

i) General equipment interface tests :

a) Insulated voltage withstand tests

b) Damped oscillatory waves disturbance test

c) Fast transient bursts disturbance test

d) Electrostatic discharge disturbance test

e) Radiated electromagnetic field test

f) RF disturbance emission test

ii) Specific power supply tests

a) Power supply variations

b) Interruptions

c) LF disturbance emission

d) Reverse polarity

iii) Tele-protection system performance tests

a) Security

b) Dependability

c) Jitter

d) Recovery time

e) Transmission time

f) Alarm functions

g) Temperature and Humidity tests (As per IEC 68-2)

- Dry heat test (50°C for 8 hours)

- Low temperature test (-5°C for 8 hours)

- Damp heat test (40°C/95%RH for 8 hours)

All the above tests at i, ii & iii (except temperature & humidity tests) shall be as per IEC

60834-1 and the standards mentioned therein.

iv) Relays

a) Impulse voltage withstand test as per IEC 60255.

b) High frequency disturbance test as per IEC 60255.

The protection signalling equipment shall be of modular construction and preferably mounted in the Relay panels. Cabling between the protection signalling equipment & Protection relays and between protection signalling equipment & Communication equipment shall be in the scope of bidder.

The input/output interface to the protection equipment shall be achieved by means of relays and the input/output rack wiring shall be carefully segregated from other shelf/cubicle wiring.

The isolation requirements of the protection interface shall be for 2kV rms.

1.4 Major technical Particulars

The major technical particulars of protection signalling equipment shall be as follows.

i) Power supply 48V DC +10%, -10%

ii) Number of commands 4 (four)

iii) Operating time <7 ms

iv) Back to back operate time without propagation delay ≤ 8 ms

v) Interface to Protection relays

Input: Contact Rating:

Rated voltage : 250 volts DC

Maximum current rating: 5 amps

Output: Contact Rating:

Rated voltage : 250 volts DC

Rated current : 0.1 A DC

Other parameters : As per IEC-255-0-20

vi) Alarm contact

Rated voltage : 250 volts DC

Rated current : 0.1 A DC Other parameters : As per IEC-255-0-20

vii) Digital communication interface: G 703(E1)

ANNEXURE IV

Technical Specification for Visual Monitoring System

Visual monitoring system for watch and ward of Substation premises:

Visual monitoring system (VMS) for effective watch and ward of substation premises covering the areas of entire switchyard, Control Room cum Administrative building, Firefighting pump house, stores and main gate, shall be provided. The contractor shall design, supply, erect, test and commission the complete system including cameras, Digital video recorder system, mounting arrangement for cameras, cables, LAN Switches, UPS and any other items/accessories required to complete the system. To provide all the necessary licenses to run the system successfully shall be in the scope of contractor.

System with Color IP Cameras for VMS surveillance would be located at various locations including indoor areas and outdoor switchyard and as per the direction of Engineer-In- Charge. The VMS data partly/completely shall be recorded (minimum for 15 days) and stored on network video recorder.

The number of cameras and their locations shall be decided in such a way that any location covered in the area can be scanned. The cameras shall be located in such a way to monitor at least:

(a) The operation of each and every isolator pole of the complete yard in case of AIS Sub-station.

(b) The Operation of each bay bays of GIS Hall as Applicable.

(c) All the Transformer and Reactors All the Entrance doors of Control Room Building and Fire- fighting Pump House, GIS Hall and Switchyard Panel room as applicable.

(d) All the gates of switchyard.

(e) Main entrance Gate

(f) All other Major AIS Equipment (such as CB, CT, CVT, SA etc. as applicable)

The cameras can be mounted on structures, buildings or any other suitable mounting arrangement to be provided by the contractor.

Technical requirements of major equipment of Visual Monitoring System

The Video Monitoring system shall be an integrated system with IP network centric functional and management architecture aimed at providing high-speed manual/automatic operation for best performance.

The system should facilitate viewing of live and recorded images and controlling of all cameras by the authorized users.

The system shall use video signals from various types of indoor/outdoor CCD colour cameras installed at different locations, process them for viewing on workstations/monitors in the control Room and simultaneously record all the cameras after compression using H 264/MPEG 4 or better standard. Mouse/Joystick-Keyboard controllers shall be used for Pan, Tilt, Zoom, and other functions of desired cameras.

The System shall provide sufficient storage of all the camera recordings for a period of 15 days or more @ 25 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras. It shall be ensured that data once recorded shall not be altered by any means. The recording resolution and frame rate for each camera shall be user programmable.

The surveillance VMS System shall operate on 230 V, 50 Hz single-phase power supply. System shall have back up UPS power supply meeting the power supply need of all the cameras in the stations including those which are installed at gate for a period of 2 hours. The bidder shall submit the sizing calculation for the UPS considering the total load requirement of Video Monitoring System.

System requirements:

a. System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording.

b. All cameras may be connected through a suitable LAN which shall be able to perform in 132 kV class sub-station environment without fail.

c. All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.

d. Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

e. Facility of Camera recording in HD (1280X720p), D1 , 4CIF , CIF, VGA, as well as in any combination i.e. any camera can be recorded in any quality.

f. System to have facility of 100% additional camera installation beyond the originally planned capacity.

g. In order to optimize the memory, while recording, video shall be compressed using H 264/MPEG-4 or better standard and streamed over the IP network.

h. System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.

i. The offered system shall have facility to export the desired portion of clipping (from a specific date/time to another specific date/time) on CD or DVD or Pendrive. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.

j. System shall have provision of WAN connectivity for remote monitoring.

k. The equipment should generally conform to Electro magnetic compatibility requirements for outdoor equipment in EHV switchyards. The major EMC required for Cameras and other equipment shall be as under:

1. Electrical Fast Transient (Level 4) – As per IEC 61000-4-4
2. Damped Oscillatory (1 MHz and 100 KHz) (level 3) – As per IEC 61000-4-
3. AC Voltage Dips & Interruption/Variation (class 3) – As per IEC 61000-4-
4. Electrostatic Discharge (Level 4) – As per IEC 61000-4-2
5. Power Frequency Magnetic Field (level 4) – As per IEC 61000-4-8
6. Ripple on DC input Power Supply Port immunity test(level - As per IEC 61000-4-

Type test reports to establish compliance with the above requirement shall be submitted during detailed engineering.

VIDEO SURVEILLANCE APPLICATION SOFTWARE

a) Digital video surveillance control software should be capable to display and manage the entire surveillance system. It should be capable of supporting variety of devices such as cameras, video encoder, Servers, NAS boxes/Raid backup device etc.

b) The software should have inbuilt facility to store configuration of encoders and cameras.

c) The software should Support flexible 1/2/4/8/16/32 Windows Split screen display mode and scroll mode on the PC monitor.

d) The software should be able to control all cameras i.e. PTZ control, Iris control, auto / manual focus, and color balance of camera, Selection of presets, Video tour selection etc.

e) The software should have user access authority configurable on per device or per device group basis. The system shall provide user activity log with user ID, time stamp, action performed, etc.

f) The users should be on a hierarchical basis as assigned by the administrator.
The higher priority person can take control of cameras, which are already being controlled by a lower priority user.

g) It should have recording modes viz. continuous, manual, or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using scheduled configuration. It should also be possible to search and replay the recorded images on date, time and camera-wise. It should provide onscreen controls for remote operation of PTZ cameras. It should have the facility for scheduled recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.

h) The software for clients should also be working on a browser based system for remote users. This will allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.

i) Retrieval: The VMS application should allow retrieval of data instantaneously or any date / time interval chosen through search functionality of the application software. In case data is older than 15 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any drives like DVD's or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system.

j) VMS shall provide the full functionality reporting tool which can provide reports for user login/logoff, camera accessibility report, server health check reports etc.

Network video recorder

The Network Video recorder shall include at least Server (min 3.0 GHZ, 4GB RAM, 3000GB HDD(min)), RAID 5 ,with suitable configuration along with Colored TFT 22" High resolution monitor, and Internal DVD writer. Windows 7/10/11 Prof. or VMS compatible operating system latest version with hardware like graphic cards, licensed Anti-virus etc.

Further the digital video recorder shall conform to the following requirements:

1.	Server Spec	Intel Quad Core (or better) 3.0 Ghz (min.) , 8 MB Cache , 4 GB memory , with suitable NVIDIA graphics card,3 TB HDD , Raid 5
2.	Recording and Display Frame Rate	Real-time 25 frames per second per channel , manual select

3.	Recording Resolution	(PAL): 1280X720 , 704(H) x 586(V) It should be possible to select lower resolutions
4.	Compression Method	H.264/MPEG-4 or better and latest
5.	Video Motion Detection Capable	Standard and built-in (selectable in menu)
6.	Monitoring Options	Split screen 1, 2, 4 , 8, 16, 32 or more cameras
7.	Playback Options	Search, still image capture
8.	Alarm/Event Recording Capable	To be provided with built-in external alarm input/ output ports minimum(8 in, 2 out)
9.	Network Operation Capable	To be provided by using WAN or LAN router
10.	Remote Internet Viewing Capable	Using WAN or LAN router
11.	HDD Storage Consumption	1GB ~ per hour / channel variable based on frame speed and resolution settings, as well as compression
12.	Operation	Triplex operation (simultaneous recording, playback, network operation)
13.	Number of Video Channel	32
14.	Audio Recording Capable	32
15.	Input Voltage	230V AC or equivalent with UPS as a
		back up for 30 minutes.

VMS Camera

a) The color IP camera for substation shall have PAN, TILT and ZOOM facilities so that it can be focused to the required location from the remote station through a controller. Whereas wireless IP cameras with PTZ controls are required for installation at gates of the Substation premises as per the direction of Engineer-In-Charge

b) The IP Camera at the main gate can be fixed or PTZ based and shall be used for monitoring entry and exit

c) It should have sufficient range for viewing all the poles of isolators and other equipments with high degree of clarity.

d) The VMS camera shall be suitable for wall mounting, ceiling mounting and switchyard structure mounting.

e) It shall be possible to define at 128 selectable preset locations so that the camera gets automatically focused on selection of the location for viewing a predefined location.

f) The camera should be able to detect motion in day & night environments having light intensity of Color: 0.5 Lux; B&W:0.05 Lux

g) Housing of cameras meant for indoor use shall be of IP 42 or better rating whereas outdoor camera housing shall be of IP 66 or better rating. Housing shall be robust and not have the effect of electromagnetic induction in 132 kV switchyard.

h) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password

i) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

A. Outdoor IP Fixed Megapixel Camera Specifications (For Main Gate)

1.	Image Sensor	2-megapixel Progressive ,1 / 3" CMOS/CCD sensor, Minimum illumination 0.1 Lux
2.	Min Luminous	0.5LUX(Color) 0.05Lux(Black)
3.	Camera Enclosure Type	IP66 Grade
4.	Iris/Focus	Auto/Manual
5.	Video Compression	Dual Stream H.264 and MPEG 4 user selectable
6.	Support Dual-stream	primary/secondary stream, H.264/MPEG 4 optional
7.	Video Definition	Primary stream:1600x1200,1280x960,1280x720,
		Secondary stream:800x600,400x288,192x144
8.	Video Parameters	Brightness, hue, contrast, saturation and image quality
9.	Video Frame Rate	PAL: 1-25frames/second NTSC:1-30frames/second
10.	Video Compression BR	32Kbit/S - 6Mbit/S
11.	Video Output	One channel composite Streaming
12.	Supported Protocols	TCP, UDP, IP, HTTP, FTP, SMTP, DHCP, DNS,ARP, ICMP, POP3, NTP, IPsec, UpnP, RTP, RTCP
13.	Operating Temperature	-5 ~ +50Ĵ
14.	Operating Humidity	10 ~ 90%

B. Outdoor IP66 PTZ HD Camera Specifications (For Switch Yards)

1.	Image sensor	1/3 type Solid State Progressive Scan CCD,WDR(High Definition)
2.	Security	Multiple user access with password protection
3.	Effective Pixels	(PAL): Main Stream：1280x720 Sub Stream：640x360、320x280 selectable
4.	Compression	Dual Stream H.264 and MPEG 4 user selectable
5.	Signal System	50 Hz
6.	S/N (signal to noise) Ratio	Better than 50 dB
7.	Electronic Shutter	1/60 ~ 1/10,000 sec. automatic or better
8.	Scanning System	Progressive/interlace
9.	Low Light Sensitivity (lux)	Color: 0.5 Lux; B&W:0.02 Lux
10.	Lens	Minimum 10x (minimum) optical in High Definition (The system shall be able to zoom the images on the monitor without any distortion to the maximum level of optical zoom)
11.	Lens Size	Minimum 4.1~73.8 mm
12.	Lens Aperture	F1.6(wide)~F2.8(tele), f=4.1~41.0mm, 10X Zoom, Video Auto Focus Angle of View Horizontal : 52°(wide) , 2.8°(tele)
13.	PTZ Data Transfer Baud/Bit Rates Supported	Selectable 2400 bps / 4800 bps / 9600 bps
14.	Panning Range	Complete 360 degrees (horizontal)
15.	Pan Speed	Adjustable, 0.1 degrees / second ~ 250 degrees / second
16.	Tilting Range	Minimum 180° Tilt Rotation
17.	Tilt Speed	Adjustable, 0.1 degrees / second ~ 150 degrees / second
18.	In Built Storage	Camera should have inbuilt storage TF or SD format for recording and storing Pictures
19.	IP Class	IP66 Standard
20.	Working temperature	-0 ~ +50
21.	Working Humidity	10 ~ 90%

PTZ-Keyboards

The features of PTZ shall include:

- Fully functional dynamic keyboard/joystick controllers
- Controls all pan, tilt, zoom, iris, preset functions
- Control up to 255 units from a single keyboard
- Many preset options and advanced tour programming
- Compatible with all connected cameras

1.	Key Application	wired keyboard control operation of PTZ functions for weatherproof dome cameras
2.	Pan / Tilt / Zoom Protocol Languages Supported	Selectable
3.	PTZ Data Transfer Baud Rates Supported	selectable 1200 bps / 2400 bps / 4800 bps / 9600 bps
4.	Additional Features	dynamic joystick for smooth camera movements, preset location option for quick access to frequently monitored areas

Annexure-V

Specification for Revenue Meter & Metering (Instrument) Transformer

General

The units shall be suitable for operating in Outdoor environment and shall be manufactured by International Reputed ISO 9001 Company

Energy Meter

The Energy Meter shall have the following minimum requirement

Type	Electronic, 3Phase, 4wire, Wye Connection, Bi- directional
Accuracy Class	0.2
Applicable Standard	IEC 687 (latest edition) or Equivalent
Measurement	a) Polyphase Quantities kWh, kVARh, kVAh
	b) Instantaneous Quantities Real Time, kW, kVA, PF, Volts,Amps,Frequency
Rated Current (In)	5A or 1A
Rated Maximum Current	1.2*In
Starting Current	0.001*In
Voltage (Phase)	110V/√3
Frequency	50Hz
Programmable Interval length	At least 1 to 30 min
Load Profile Memory Storage	At Least 60 days of storage using 4 channels at 15min Intervals
Channels of Load Profile Data	At Least 4 channels of storage (kWh import, kWh export, kVARh Import, kVARh export)
Other Features to be Included	Serial communication port and Accessories 1. Optical Port Communication (With optical Probe) 2. Remote Download Modem (in built) Hardware Key to Prevent any Calibration and configuration change 3. PT or CT error gain correction 4.Non Volatile memory 5 Inbuilt Super capacitor 6 Meter shall be able to record and store in Non-Volatile memory the instant of Power failure and the instant of supply restoration.

ANNEXURE VI

TECHNICAL SPECIFICATION OF PABX EQUIPMENT

a. General

This section provides the functional and performance requirements for the PABX system. The Bidder is encouraged to propose any hardware configurations better suited to the characteristics of the Bidder's standard products as long as the equipment characteristic requirements of this specification are met.

The PABX must be capable of operating in the high EMI environment of substations and power plants, and without air conditioning. The bidder shall provide performance certificate from at least one customer for satisfactory operation of one year.

The Contractor shall be responsible for the installation and implementation of the PABX provided under this procurement along with the interfaces, associated hardware & accessories. This shall include the development of the database, system tests and training of Employer staff.

The following are the minimum requirements for PABX system.

b. Technical Requirement

The Contractor shall be responsible for providing state of the art TDM/PCM based PABX system. The offered PABX shall be modular in nature with universal slot architecture to facilitate future expansion requirements. Expansion shall require only procurement and installation of respective interface cards.

The exchange transmission performance shall comply with the ITU-T standards. The Contractor shall provide the details of standards conforming to the product supplied. The offered PABX must be capable of interfacing with 4-wire E&M VF channels provided by Power Line Carrier System (PLCC), E1 (G.703) / Ethernet channels provided by wideband communication equipment and 2 wire LS or 4 wire E&M channels provided by primary multiplexers. The PABX shall also be designed to operate over 2 wire leased telephone land line of other telecommunication provider.

All interfacing equipment necessary for satisfactory operation and to comply with the local regulation shall be provided under this procurement.

The Contractor shall ensure that the speech level and signal-to-noise ratio are satisfactory under all conditions likely to be encountered on the system. The offered PABX shall be integrated with existing PABXs. Any interfaces required for proper matching and connection with existing PABX equipment shall be provided by the Contractor. It shall support at a minimum the following features:

i. SPC (Stored Program Control) type
ii. 100% non blocking switch with PCM-TDM
iii. Redundant processors or distributed processing architecture
iv. 2 Wire interfaces for local subscribers & remote subscriber
v. 4 Wire E&M interfaces for two way trunks
vi. Extensions should be extendable over a distance of 300meters
vii. E1 Interface using Electrical (through copper cable) connection to existing SDH equipments.
viii. Provision of suitable interface for VOIP connectivity (50 Nos)
ix. Printer interface
x. Extensions shall support DTMF & Pulse dial phones

xi. Extensions shall support analog phones/fax machines
xii. Ringer/Tone card for different tones and ring generation
xiii. DID (Direct Inward dialing)
xiv. DOD(Direct Outward dialing))
xv. Executive Override enabled
xvi. Provision of Voice mail
xvii. Call forwarding and Call pickup
xviii. Circular hunting within a defined group
xix. Automatic call back
xx. Calling Line Identification Presentation (CLIP) support
xxi. Howler tone for receiver-not-on-hook warning

The Contractor shall provide the suitable system for PABX configuration such as class of service, feature assignment, line and trunk access etc. Further, it shall be possible to make on-line changes to the database and shall be user friendly. In case, the bidder offers a PC based PABX configuration system, the PC/workstation shall be of reputed make (Compaq/HP/IBM/Dell) with 15" TFT Color monitor.

The Contractor shall install the telephone extensions as well as terminate the voice trunks along with requisite cable, PVC conduit/channels and other installation hardware.
The PABX shall be supplied with a MDF which may be housed inside the PABX cabinet or in a separate enclosure suitable for wall mounting.

The PABX shall be able to operate on -48 Volt DC (nominal). It shall have power supply and control cards in hot-standby mode so that in case of failure of one the other takes over automatically. Alternatively, distributed power supply architecture is also acceptable.

c. **Equipment Availability:** PABX system shall have 99.99% availability. Equipment shall be capable of providing suitable alarm indication in order to determine malfunction/fault condition.

d. **Testing & Inspection:**

The offered PABX shall be type tested as per relevant standards. The bidder shall submit the previous type test reports. The FAT & SAT for PABX shall be conducted as per requirement specified in this Section.

e. **Factory Acceptance Tests**

Factory acceptance tests shall be conducted on final assemblies of all equipment to be supplied.

Equipment/Material shall not be dispatched to the Employer until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued Material Inspection & Clearance Certificate (MICC). Successful completion of the factory tests and the Employer approval to dispatch shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's/Owner's authorised representatives.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the Employer.

The factory acceptance test shall demonstrate the technical characteristics of the equipment in relation to this specifications and approved drawings and documents. The factory acceptance tests shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's /supplier's) standard FAT testing program which shall be finalised during detailed during engineering. In general the FAT shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics etc.

f. **Production Testing**

Production testing shall mean those tests which are to be carried out during the process of production by the Contractor to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Contractor's standard quality assurance procedures. The production tests to be carried out shall be listed in the Manufacturing Quality Plan (MQP), along with information such as sampling frequency, applicable standards, acceptance criteria etc.

The production tests would normally not be witnessed by the Employer. However, the Employer reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

g. **Site Acceptance Tests (SAT)**

The Contractor shall be responsible for carrying out site tests and inspection for all equipment supplied in this contract as required by the Employer. All equipment shall be tested on site under the conditions in which it will normally operate. The site acceptance tests shall be proposed by the Contractor in accordance with technical specifications and Contractor's(including Sub-Contractor's /supplier's) standard Site Acceptance Testing program which shall be finalised during detailed during engineering.The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified.

ANNEXURE – VII

I. 11kV ISOLATOR

C11.1	Type	Outdoor (Double Break) without E/S
C11.3	Standard	IEC 2271-102
C11.4	Number of terminals in control cabinet (Interpole cabling shall be Supplied by contractor)	All contacts and control circuits are to be wired upto control **cabinet plus 24 terminals exclusively for Owner's use.**
C11.5	Rated current	400A.
C11.6	Rated short time withstand current of isolator and earth switch	25 kA for 3 Sec
C11.7	Rated dynamic short circuit withstand current of isolator and earth switch	As per IEC
C11.8	Operating mechanism for Isolator and Earth switch	Manual
C11.9	No. of auxiliary contacts on each isolator	5 NO + 5 NC contacts, wired to terminal block exclusively for Owner's use in future.
C11.10	No. of auxiliary contacts on each switch for Owner's use in future	3 NO + 3 NC contacts wired earthing to terminal block exclusively

Annexure VIII - EMP Mitigation and Monitoring Plans

Table 10.A Environmental Mitigation Plan

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
Project-wide EMP							
Detailed design and pre-construction preparations							
General							
Compliance with national regulations and international good practice guidelines.	Environment, health, and safety impacts and risks of the project in general	• NEA and Contractor to ensure compliance with national and international regulatory framework as set out in Section II of the IEE, including ADB Safeguard Policy Statement (2009), IFC EHS General Guidelines (April 2007), and IFC EHS Guidelines for Electric Power Transmission and Distribution (April 2007) plus other applicable environment, health and safety laws and regulations in force during project implementation, in addition to any further mitigation measures set out in this EMP.	No breaches of national regulations and/or international good practice guidelines.	PMD to comply with requirements throughout project implementation. PMD supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout contract implementation.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line
Grievance Redress Mechanism (GRM).	Environment, health, and safety impacts and risks of the project on affected persons; including construction workers and affected local communities	• NEA with support of Contractor to establish multi-level GRM as per Section VII of IEE, including identification of GRM Officers at all GRM levels and Grievance Redress Committee members. • NEA and Contractor to carry out community awareness raising during community meetings and one-to-one discussions about the GRM with directly affected persons before the commencement of works including details of how to submit a grievance to either NEA and/or the Contractor, consultations are to be documented. • NEA and Contractor to disseminate GRM contact details verbally and by SMS as well as through distribution of leaflets, and prominently posting GRM arrangements on noticeboards located at the project sites and at local NEA offices, project substations, community centers etc. • Contractor to carry out awareness raising amongst workers about the GRM at the start of their	GRM operationalized upon loan effectiveness, affected persons are aware of its existence and are actively using GRM to raise their grievances. 100% of grievances received are resolved in a timely manner by NEA and Contractor. Details of GRM operationalization including photos of awareness raising activities to be submitted in first	PMD to comply with requirements throughout project implementation. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout contract implementation.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing GRM as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		employment on-site, including details of how to submit a grievance to either NEA and/or the Contractor. Disseminate GRM contact details verbally and by SMS as well as through noticeboards located at temporary construction workers camps and construction site offices. • Contractor to ensure that throughout construction, signage is prominently visible detailing site and office contacts in case of grievance. • NEA and Contractor to encourage affected persons to make use of the GRM yet clarify that this does not prevent them from pursuing any legal action, if they feel that it is needed. • NEA and Contractor to inform communities about the ADB Accountability Mechanism and their possibility to resort to it if any of their grievance is not resolved by the project's GRM. • NEA and Contractor to keep record of grievances received and their resolution as report on these, as per Section VII of the IEE.	monitoring report, records and grievances and their resolution specified in subsequent monitoring reports.				
Environment safeguards staffing – see also site-specific measures for additional staffing requirements	Environment, health, and safety impacts and risks of the project in general	**PMD:** • NEA to operationalize the formal, fully functional environment and social safeguard safeguards unit within PMD and provide requisite facilities and equipment to enable its operation. • NEA to assign / start appointing suitably qualified and experienced environmental safeguards team, under the direction of the safeguards unit, to support EMP implementation and be responsible for undertaking regular on-site supervision and monitoring of the project. The environmental safeguards team for the project will comprise: (i) a full-time Senior Environment Officer, (ii) a full-time Senior Health and Safety Officer, (iii) a full-time Senior Biodiversity Officer, (iii) 2 full-time Junior EHS Field Officers, who are to be based on-site during the construction period, and (v) a full-time Community Engagement/GRM Officer. • PMD and environment safeguards team to oversee EMP implementation, providing guidance on corrective action as required, and recording	PMD environment and social safeguard safeguards unit has been operationalized. 100% of required staffing has been recruited to oversee EMP implementation during detailed design, pre-construction, construction, and operation & maintenance. PMD environment safeguards team and PSC shall be ready and on-board upon loan effectiveness.	PMD to comply with requirements by establishing environment and social safeguard safeguards unit within PMD and appointing required staff for the duration of the project. PMD to supervise and monitor contractor to ensure their compliance with these requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements and appoint required staff for the duration of their contract.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of safeguards staffing as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		construction activities and environment, health, and safety conditions on-site through photos and notes. • PMD senior officers to undertake at least monthly supervision visits as well as periodic "spot check" site visits to all contract packages whilst directing supervision efforts towards the most environmentally sensitive components of the project. **PSC:** • NEA to recruit PSC, including international environment safeguard specialist, international health and safety specialist, international biodiversity specialist, international heritage specialist as well as national equivalents in accordance with TOR agreed with ADB. • PSC to assist PMD to oversee EMP implementation, providing NEA and Contractor with guidance on corrective action as required, and recording construction activities and environment, health, and safety conditions on-site through photos and notes. • PSC to visit all contract packages at least semiannually during ongoing construction works whilst directing their supervision efforts towards the most environmentally sensitive components. **Contractor:** • Contractor to employ as part of the team delivering each package at least one suitably qualified and experienced, dedicated, environment officer and at least one suitably qualified and experienced, dedicated, health and safety officer responsible to be based on-site and monitor and supervise safeguards implementation on a day-to-day basis for the duration of the works. • Contractor to nominate a community engagement/GRM officer as part of the team delivering each package/lot to be based on-site and keep affected persons informed of the status of works and be available to receive and deal with any	Contractor environment safeguards team appointed upon commencement of contract, CVs for approval of environment safeguard team submitted as part of bid or subsequently for approval of NEA before field mobilization. List of staff and copies of CVs to be submitted in first monitoring report, any updates/changes in staffing specified in subsequent monitoring reports.				

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		grievances at the project site level, for all new transmission lines this will be a dedicated officer. • Contractor's environment safeguard team to oversee EMP implementation, providing guidance on corrective action as required, and recording construction activities and environment, health, and safety conditions on-site through photos and notes. • Contractor's environment safeguard team will be based on-site. • Contractor to ensure each active construction site or team has a project manager based on-site full-time who is nominated to the role of EHS Supervisor with responsibility for ensuring EMP implementation by their site/team, acting on the advice of, and reporting to the environment safeguards team on compliance. Project manager will be supported by full time OHS steward(s) for each construction site/team who will supervise all works. • NEA and Contractor should not discriminate and should proactively encourage the employment of suitably skilled women on the project.					
Biodiversity management – see also site-specific EMP	Impacts on biodiversity including biodiversity of Chure Conservation Area	• NEA will ensure that except for Dumkibas Substation and Chobar-Lagankhel Underground Transmission Line all other project components will be situated outside the boundaries and buffer zones of current or proposed protected areas and/or key biodiversity areas. • NEA will ensure that none of the project components including temporary construction facilities is situated within forest area. • Contractor's detailed designs and CEMP will be reviewed by the PSC International Biodiversity Specialist to confirm biodiversity impacts have been minimized before approval of detailed designs.	Project meets the SPS requirements for legally protected areas before issue of related bidding documents. Final IEE/EMP documents consultations and reflects the mitigation measures required by and support for promotion/enhancement measures agreed with the protected area management Detailed designs minimize biodiversity impacts, reflect	PMD to comply with requirements prior to issue of bidding documents, approval of detailed design and before the commencement of works. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor. PSC to help develop capacity of NEA and be responsible for reviews of Contractor's documentation.	Contractor to comply with requirements prior to approval of detailed design and before the commencement of works.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
			international good practice for "bird sensitive" design and respond to any concerns raised by Bird Conservation Nepal.				
Protected area management consultation and physical cultural resources management – see also site-specific EMP for Chobar-Lagankhel UG Line in Kathmandu Valley	Impacts on physical cultural resources of Kathmandu Valley Cultural, Religious and Archeological Sites from construction of Chobar-Lagankhel UG transmission line	• NEA will ensure that all project components are sited and designed to avoid significant damage to physical cultural resources. • NEA will ensure that none of the project components are situated within the boundaries or buffer zones of current or proposed World Heritage Sites or any other area of national archeological or cultural significance. • Contractor will confirm during detailed route surveys that no physical cultural resources of local importance fall in the footprint or right of way of the transmission lines.	Detailed designs minimize impacts on identified physical cultural resources and respond to concerns raised by their users.	PMD to comply with requirements prior to issue of bidding documents, approval of detailed design and before the commencement of works. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor. International Heritage Expert of PSC to help develop capacity of NEA and be responsible for reviews of Contractor's documentation.	Contractor to comply with requirements prior to approval of detailed design and before the commencement of works.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line
Meaningful consultations with affected people and other concerned stakeholders.	Environment, health, and safety impacts and risks of the project in general, community could be disrupted and disturbed by works hence they need to be consulted and kept well informed about the project and its progress	• NEA with the support of the PSC to prepare detailed communication/consultation plan upon loan effectiveness. • NEA will not award any contract for project components until meaningful consultation requirements are confirmed as met by ADB. • NEA to undertake additional meaningful consultations covering all project components with affected people and other concerned stakeholders such as Rural	Detailed communication/ consultation plan reflecting final EMP requirements developed upon loan effectiveness.	PMD to comply with requirements prior to issue of bidding documents and before the commencement of works.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and	Contractor to comply with requirements prior to the commencement of works, and then continue to remain actively involved with the	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		Municipalities as detailed in Section VI prior to the issue of bidding documents utilizing the agreed questionnaires. In particular, ensure all local affected communities within 500m of substations and the overhead transmission line and 100m of the underground transmission line have been informed of the project through NEA local offices and contact with village heads or equivalent, have had the opportunity to be actively involved in the design process and that any concerns raised have been duly addressed. For Kathmandu Valley component (Chobar-Lagankhel UG transmission line) assistance through the Kathmandu Valley Development Authority may be sought to keep affected communities informed of the project works. • For all new substations requiring permanent water supply etc. NEA to consult with and seek the agreement of local communities to use any community resources (e.g., water supplies, village ponds) to identify any potential conflict. If additional demand may place stress on community resources plan for alternative sourcing for these resources for project needs. • NEA to ensure the final IEE/EMP documents the consultations undertaken and demonstrates how concerns raised have been responded to. • During detailed route surveys, Contractor to consult one-on-one with all affected persons within ROW of transmission lines as well as all persons occupying properties in close proximity to the substations up to 500m and within the ROW up to 50m of the transmission line alignment, to seek their views and respond to individual environment, health, and safety concerns about alignment. Obtain no objection from private landowners. • Contractor to consult with and seek the agreement of local communities on their proposed locations for any temporary construction workers camps, site offices, storage areas, and areas for waste management, etc. • Contractor to consult with and seek the agreement of local communities to temporarily use any community resources (e.g., water supplies, village ponds) during	Meaningful consultations for all project components undertaken, documented, and reported on in final IEE. Local communities and other concerned stakeholders kept informed throughout project implementation. Details of ongoing consultations, including photos and records of participants (including gender) documented and included in monitoring reports.	PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	monitoring of the contractor. International Environment Expert to help develop capacity of NEA and prepare detailed communication /consultation plan.	local communities through ongoing consultations throughout contract duration. .	

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		construction to identify any potential conflict, if additional demand may place stress on community resources plan for alternative sourcing for these resources for project needs. • Contractor to communicate at least four weeks (one month) prior to the commencement of works, advance notice to local communities within 500m of substations and transmission lines verbally through NEA local offices and contact with village heads and through notices, pamphlets or similar in Nepali about the agreed schedule of and details of planned construction works in their area to help manage any disruption and disturbance and potential conflicts with local communities. • Contractor to continue to undertake one-on-one consultation with affected persons, especially those within ROW of transmission lines and whose properties are within 100m of new substations who will be most impacted to keep them fully informed of the nature of works and latest schedule, notifying them at least four weeks (one month) prior to the commencement of works of intended start date and schedule. • NEA and Contractor to ensure, in the context of the COVID-19 pandemic, that all consultations are carried out following latest national COVID-19 requirements and WHO social distancing and hygiene guidelines as detailed in Appendix 8 of the IEE. • Consultations undertaken during project implementation will be documented as reported in either final/updated IEE or attached to periodic monitoring reports.					
Obtain national EIA/IEE approvals, and other EHS permits and licenses	Environment, health, and safety impacts and risks of the project in general	• NEA to ensure all national EIA/IEE required are approved by the responsible authority prior to the start of any bidding process. • Contractor to comply with the conditions of the national EIA/IEE, if there is any conflict between the measures set out in this EMP and the national EIA/IEE	National EIA/IEE clearances obtained prior to the issue of bidding documents.	PMD to comply with requirements prior to issue of bidding documents and start of any works.	PSC to supervise, monitor, and assist PMD in ensuring their own	Contractor to comply with requirements prior to the commencement of works, and to	NEA counterpart funds Part of PSC budget

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		conditions most stringent provision will take precedence. • Contractor to acquire all other national EHS permits and licenses required by national laws and regulations, ensuring that these are all obtained before start of related works, including enabling works.	100% of applicable clearances, permits and licenses obtained prior to the start of works. Copies of clearances, permits and licenses to be submitted with monitoring reports.	PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	compliance and assist with supervision and monitoring of the contractor.	comply with any conditions imposed throughout contract duration. .	Part of contract cost, include costs of implementing EMP as BOQ line
Update and disclose IEE prior to contract award, update as required to reflect detailed designs.	Environment, health, and safety impacts and risks of the project in general	• NEA to update the IEE to reflect additional meaningful consultation and national environmental clearance conditions for ADB clearance and disclosure prior to contract award. • NEA to review the final IEE following the completion of the detailed designs and update it, as required, to reflect the detailed design for all project components, and obtain ADB's clearance before the commencement of any works, including enabling works. • If a change in project scope or design occurs during project implementation or if unanticipated impacts are identified at any point during project implementation NEA to inform ADB and, if deemed appropriate, NEA will update the IEE for clearance and disclosure by ADB. Project components having associated facility unable to avoid significant irreversible impacts post-mitigation on protected areas, natural and critical habitat do not qualify for financing under this project. NEA will ensure all associated facility of the project comply with national laws and regulations, and are consistent with SPS requirements by requiring them to comply with this EMP. • NEA to locally disclose in a timely manner the final IEE, any subsequent updates to it, and other environmental safeguards documentation by posting them on the NEA website and ensuring full copies of the latest IEE and its executive summary translated into Nepali are available at all local NEA offices and	Updated IEE cleared and disclosed by ADB prior to contract award. IEE updated, as required, to reflect the detailed design for all project components prior to the start of any works. Final IEE, any subsequent updates to it, and other environmental safeguards documentation are locally disclosed.	PMD to comply with requirements prior to issue of bidding documents and before the commencement of works. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance. PSC to support PMD in finalizing and updating IEE/EMP documentation.	Contractor to immediately inform NEA if any unanticipated impacts are identified at any point and make a copy of the latest IEE available at the project sites.	NEA counterpart funds, including costs of printing Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

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		project substations. Notices will also be placed on noticeboards at the project sites and local NEA offices and pamphlets should be distributed in the project areas in Nepali, informing of the main findings of the IEE and the availability of the IEE and reports with notice given that help with their translation into Nepali and affected persons' dialects will be extended free of charge on request.					
Bidding and contract documentation, contractor, and subcontractor management.	Environment, health, and safety impacts and risks of the project in general	• NEA to ensure the final EMP cleared by ADB is included prior to the issue of bidding documents and contract award. • NEA will ensure the requirement to comply with the final EMP forms an integral and binding part of the contract, including appropriate incentives and/or penalties for (non-)compliance related to their environment, health, and safety management. • Contractor will preferably have in place corporate environment, health and safety policies and corporate environment, health, and safety management system certifications, such as, ISO 14001 for environment, ISO 45001 for health and safety, or equivalents. • Contractor will comply with all relevant provisions of the final EMP and any updates to it following detailed designs or in response to any unanticipated impacts, they will be responsible for implementing and budgeting for all the measures required. • Contractor will comply with any corrective action plan required and cover the costs where corrective action is required due to non-compliance on behalf of the contractor, its subcontractors or third parties. • Contractor will ensure all its subcontractors and third parties, irrespective of being formally or informally employed, also comply with the final EMP and any updates to it, as well as their own CEMP and H&S Plan, and that this responsibility is cascaded down any chain involved.	Final EMP cleared by ADB and related provisions included in all bidding and signed contract documentation. No breaches of final EMP by contractor, subcontractor or third parties with prompt corrective action taken if it is required.	PMD to comply with requirements prior to issue of bidding documents and during procurement process.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance, reviewing bidding and contract documents to ensure they reflect requirements.	Contractor to comply with requirements throughout contract implementation, ensuring adequate budget for implementing final EMP is included in their contract cost.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

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		• Contractor will not engage in any activities described on the ADB Prohibited Investment Activities List in Appendix 5 of ADB's SPS (2009) • Contractor to ensure no persons under 18 are employed on the project. • Contractor will put in place appropriate incentives and/or penalties for (non-)compliance by workers related to PPE, prohibition on firewood and NTFPs collection and fishing, hunting, or poaching by workers. • Contractor to ensure project adopting strict anti-hunting and poaching protocols for workers, undertaking conservation awareness raising activities etc. Particular care will need to be taken by workers at K-N and Dumkibas in relation to avoidance of snake bite.					
Trainings and awareness raising activities.	Environment, health, and safety impacts and risks of the project in general.	• NEA with the support of the PSC to prepare detailed training plan upon loan effectiveness elaborating how training and awareness raising activities required by the final EMP will be conducted. **<u>EHS management:</u>** • NEA with support of the PSC to conduct training sessions on EMP implementation for all those with management responsibilities under it to clarify national and ADB SPS (2009) requirements, requirements at each stage of the project, roles and responsibilities, and, record keeping and reporting requirements. • NEA with support PSC to conduct training sessions on GRM operationalization for all those with responsibilities under it, including the nominated PMD Community Engagement/GRM Officer, and all members of the grievance redress committee. • Contractor to ensure all members of its project management team, environment safeguards team, design team, construction management team, and community engagement/GRM officers attend NEA trainings.	Detailed training plan reflecting final EMP requirements developed upon loan effectiveness. Trainings and awareness raising delivered in accordance with the plan. Contractor and construction workers fully aware of their responsibilities under EMP through training. Details of training and awareness raising sessions, including photos and records of participants (including gender) documented	PMD to comply with requirements throughout project implementation, including conducting training sessions and ensuring relevant staff attendance. PMD supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor. PSC to develop training materials for NEA, act as resource person to deliver them, and ensure relevant specialists' attendance.	Contractor to comply with requirements throughout contract implementation, including conducting training sessions and ensuring relevant staff attendance.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line Indicative costs for trainings and awareness raising are included in the EMP budget table

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		• Training of all PMD and O&M staff on the climate change impact of SF6, alternatives, H&S risks during O&M due to presence of toxic byproducts, leakage minimization, and environmentally sound and safe disposal of old equipment with SF6 **<u>Construction workers:</u>** • Contractor to conduct training for construction management and provide all workers and visitors on-site, irrespective of them being formally or informally employed by contractor, subcontractor or third-party with an environmental, health and safety induction before being allowed on-site including do's and don'ts in relation to construction site, temporary workers camps, local communities, protected areas, etc. • Contractor to ensure topics covered by training and induction will include but not be limited to: good housekeeping at all times; environmentally sound waste management practices; hygiene and communicable disease prevention including COVID-19 and HIV/AIDS; snake and rodent bites and precautionary measures for avoidance i.e. avoid work after rain, flood, and in the crop ripening seasons, caution while putting hands in holes; sexual exploitation, abuse and harassment prevention; culturally acceptable practices; biodiversity conservation awareness; fire safety prevention; prohibition on firewood and NTFPs collection by workers; prohibition on fishing, hunting, or poaching by workers; heritage conservation awareness; chance find procedures; OHS, including use of PPE; etc. • Contractor to conduct training for construction management and regular drills involving workers irrespective of them being formally or informally employed by contractor, subcontractor or third-party on emergency preparedness and response procedures in case of an environmental or health and safety incident including spillage, fire, natural disaster, disease outbreak etc. Training for	and included in monitoring reports.				

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		construction management will include modules on first aid and fire safety including include training on how to use first aid and firefighting equipment provided on-site and the scenario of potential or confirmed COVID-19 infection on-site. • Contractor to continue to deliver short environmental, health and safety refresher sessions to construction management and all workers on a monthly basis throughout construction period, and cover pertinent environmental, health and safety topics on daily basis in toolbox talks. • Contractor to ensure workers with a specific role have attended specialized health and safety trainings related that role e.g. first aiders, fire safety officers, as well as ensuring workers have task-specific trainings for working at height, working with electricity, etc. **Community awareness:** • Contractor to undertake construction safety community awareness raising activities in local affected communities within 500m of substations and transmission lines, and especially with schools, prior to construction. • NEA to undertake electrical safety community awareness raising activities in local affected communities within 500m of substations and transmission lines prior to construction, and especially with schools, awareness raising activities to be repeated on completion of construction; to include electrocution risks, EMF, corona noise, etc.					
Detailed design.	Environment, health, and safety impacts and risks of the project in general	• NEA and Contractor to address all site-specific measures detailed in this EMP with regards biodiversity and physical cultural resources as well as other sensitive receptors during the detailed design, as well as ensuring the detailed designs reflect international engineering best practice/ good EHS practices. • Contractor's detailed designs will be reviewed by the PSC to confirm that all measures required by the final EMP have been adequately incorporated and that	NEA approved detailed designs minimize impacts and risks on environment, health and safety during construction and operation & maintenance stages.	PMD to comply with requirements prior approval of detailed design. PMD to supervise and monitor contractor to ensure their compliance	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and	Contractor to comply with requirements prior to approval of detailed design.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

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		they reflect international engineering best practice/good EHS practice before they are approved by NEA. **Disaster risk management:** • During detailed route survey identify presence of any floodplain, waterlogged or unstable land, avoid locating any project components in such locations, including areas of the Terai that get waterlogged when temporary inundation occurs during the monsoon. • Select an appropriate foundation design for substations and towers considering climatic factors such as wind, geological factors such as seismic risk, and hydrological factors such as high groundwater table or karst in the project component locations. • Given high seismic risk across the project area, design of all substation and tower foundations and any structural components (e.g., buildings) to consider seismic zone, main frontal thrust, main boundary thrust etc. and be checked for seismic safety by the design team as well as by an independent expert, separate to the design team, to confirm that international good practice seismic design standards are met. • Buildings, transmission towers, and conductors to incorporate climate adaptation measures as per the CVRA, including to withstand extreme temperatures and gale force wind speeds, at minimum equal to upper end of gale conditions on Beaufort scale (40 knots) given 30 knots experienced during the 31 March 2019 tornado event in Nepal. • Consider placement of equipment within substations to avoid water logging in operation & maintenance, ensure placement above the maximum flood level (allowing for climate change) and incorporate adequate drainage design to avoid waterlogging during the wet season.		with delegated requirements.	monitoring of the contractor. PSC to review detailed design and confirm in accordance with final EMP and reflective of international engineering best practice/good EHS practice.		

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		• Drainage will be designed so that discharge from substation site is no more than greenfield runoff rates; so as not to exacerbate flooding on land which is outside of the substation/downstream. • Set all transmission towers back by at least 100m from the edge of river banks and irrigation canals. • Detailed design to avoid locating any towers in river beds and irrigation canals, tower design at crossing locations (single wire spans) to keep tower footing away from the river and irrigation canals by 100m. • In the event towers sited in locations that get waterlogged when temporary inundation occurs during the monsoon cannot be avoided, they will be of suitable construction and raised above the high-water level. **Pollution risk management:** • Use of PCBs will be prohibited in all new transformers and any other project facilities or equipment provided by the project. • Equipment purchased by NEA or Contractor for use on the project is to be accompanied by letter from the manufacturer stating that it is guaranteed PCB free and to be labelled as PCB free before its installation. • Contractor to provide NEA with material data sheets for insulating oil meeting technical specifications for use in new transformers. • During detailed route survey identify presence of any surface waterbodies including rivers/ponds and groundwater sources including springs/wells/pumps/water spouts and confirm if any are used by local communities for drinking water. • Contractor to coordinate with Department of Water Resources and Irrigation and relevant irrigation authority where ROW crosses rivers and water channels to obtain their no objection. • Detailed design of substations to locate new transformers; storage areas; and septic tanks/soakaway ideally 500 m from any surface waterbodies and groundwater sources but at least 100m to reduce pollution risk. If closer placement is					

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		required due to substation's proximity to surface waterbodies and groundwater sources, further assessment to be carried out by Contractor to demonstrate using source-pathway-receptor model that there will be no adverse impact on aquatic ecology or human health. • Detailed design of transformers and fuel, oil chemical, and waste storage areas to incorporate impermeable concrete surface bunded to 110% volume which is not connected to the drainage system to collect spills and leaks; ideally storage areas to be 500m to water sources (surface water and groundwater wells, springs, water spouts etc.) but if this is not possible minimum distance is to be 100m. • Detailed design of fuel, oil chemical, and waste storage areas to provide for a covered storage area of sufficient size to accommodate all anticipated storage requirements, ensure storage areas have the ability to be locked, are well-ventilated and will not reach extreme temperatures. • Substation detailed design to incorporate adequate drainage; no drainage water will be permitted to discharge direct to surface water, oil interceptors are to be fitted on all drainage to catch oil spill. • Detailed design of substations to minimize cut and fill and land raising in order to reduce the extent of earthworks and thus dust generation during construction. • Detailed design of substations to ensure operation noise will be limited to the following as 1 hour LAeq: (i) 70 dB(A) at the site boundary; (ii) at residential properties, 55 (day) and 45 (night) dB(A) in urban areas and 45 (day) and 40 (night) dB(A) in rural areas as defined by Nepal regulations; and (iii) at "peace areas" such as schools as defined by Nepal regulations, 50 (day) and 40 (night) dB(A) – if these levels are already exceeded by the background, the Contractor will ensure that the noise standards are				

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		met by the project design alone and/that substation operation will not result in an increase of 3dB(A) above background levels. • Detailed design of transformers and other noise sources to locate them as far as practical from the substation site boundary since noise diminishes with distance, at minimum given transformer noise is generally in the range 60-80 dBA they are to be located at least 15m but ideally 50m from substation site boundary – if this is not possible Contractor must carry out noise calculations (modelling) to demonstrate that site boundary levels can be met. • If any properties are within 100m of the substation site boundary then baseline measurements must be carried out during detailed design and noise calculations (modelling) considering low frequencies associated with transformer hum undertaken by the Contractor to demonstrate that these noise levels will be met. • If noise levels cannot be met through siting alone and where there are properties within 100m of the substation boundary detailed design to incorporate acoustic barrier designed to international good practice around either the noise source and/or substation site boundary to attenuate noise to level such that noise levels at the receptors will be met. **Health and safety:** • Use of any asbestos containing materials is prohibited. • Include in the design of all substations and transformers within the substation a secure wall or fence with lockable entry featuring written and visual warning signs to include the ISO 7010 "Hazard Type: Electrical Symbol" warning of the risk of electrocution. • Include in the design of all towers anti-climb features together with posting of written and visual warning signs to include the ISO 7010 "Hazard Type: Electrical Symbol" warning of the risk of electrocution.					

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		• Contractor to ensure detailed design of transmission lines incorporates lightening protection to minimize fire risks. • Detailed design of substations to include fire safety measures including detector, alarm, and firefighting equipment in accordance national regulations and IFC EHS Guidelines on OHS. • Indoor work areas at substations to be well ventilated and well-lit in accordance national regulations and IFC EHS Guidelines on OHS. • Detailed design of substations to ensure EMF levels within the substation boundary are within international good practice levels as per International Commission on Non-Ionizing Radiation Protection (ICNIRP https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf) (reference and peak values) for the occupational exposure; in areas where EMF levels could be exceeded posting of written and visual warning signs. • Detailed design of substations and transmission lines to ensure EMF levels at all regularly occupied properties is within international good practice levels as per International Commission on Non-Ionizing Radiation Protection (ICNIRP) (reference and peak values) applicable to the public exposure. • Use of shielding equipment/materials to decrease electromagnetic field exposure. • Establish applicable right of way and safety clearance corridor in accordance with the Electricity Rule. During detailed route survey identify the presence and use of any structures found in the (i) right of way and (ii) safety clearance corridor. Consider re-siting of angle point towers such that any structures are outside the ROW or if not possible outside the safety clearance corridor. If it is not possible to avoid regularly occupied structures in the safety clearance corridor these are to be relocated with adequate compensation in accordance with the Resettlement					

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		Plan. Such properties must be relocated, and applicable compensation provided by NEA prior to the start of any works. Consider grounding roofs and other metallic surfaces on any properties remaining within ROW to avoid induced current and electricity related accidents. • During detailed route survey identify presence of any existing utilities such as power lines, communications, streetlights, groundwater pumps, water spouts as well as through consultation with service providers (electric, water, gas, telecoms etc.) • In cases where excavation works may be needed, including drilling or open trenching for underground cables, underground utility scans using a Cable Avoidance Tool (CAT) or equivalent must be undertaken by the Contractor to identify any services. • Contractor to coordinate with operators where ROW crosses existing utilities to obtain no objection. • Detailed design to consider the risk of damage to utilities and allow for sufficient vertical and horizontal safety clearances to minimize health and safety risks as per the Electricity Rules, and crossings for communications as per Electricity Regulation 1993. • Pit latrines and disposal of untreated sanitary wastewater to surface or groundwater is prohibited. Detailed design of substations to include adequate sanitation and welfare facilities for all NEA workers to be posted at or visiting the substations including indoor kitchen, eating and sleeping facilities (if applicable) and adequate number of indoor toilets/washrooms with a hot and cold running water supply which are connected to either existing sewerage system or to septic tank with soakaway. • Disposal of worker generated waste (e.g. plastic bottles) on-site is prohibited and adequate waste storage areas to be incorporated into the detailed design. Composting of food waste may be permitted on-site if detailed design incorporates enclosed composting facilities (enclosed to avoid attraction of vermin etc.) located away from accommodation and any properties outside the site boundary.				

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		Incineration may be permitted on-site if detailed design incorporates an enclosed, small volume solid waste incinerator with stack and pollution control that is designed for residence time and temperatures that minimize incomplete combustion for waste disposal at substation, to reduce the volume of solid waste to be removed off-site given lack of suitably engineered and licensed sanitary waste facilities in rural municipalities. • Source of drinking water that meets drinking water standards to be provided to substations. If substation is in district which suffers from arsenic contamination of drinking water, groundwater must not be used, and alternative source must be identified. If any surface or groundwater sources are proposed for use in substations, Contractor is to undertake a baseline water quality sampling per EMoP (Table 10.B) to confirm its suitability for use. If drinking water standards are not met, detailed design to consider alternative source or include water treatment facilities at the substation to facilitate safe drinking water supply. • Provide a dedicated shelter to security guards, shielding them from rain, wind, and extreme (hot and cold) temperatures. **<u>Greenhouse gas emissions:</u>** • Use of chlorofluorocarbons (CFCs) including halon is prohibited. • Detailed design of gas insulated switchgear and GIS substations will comply with international norms and standards for handling, storage, and management of SF6. • SF6 insulated equipment and GIS will be hermetically pressure sealed “sealed for life” units, tested and guaranteed by the supplier at less than 0.1% leakage rate.					

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		• Gas insulated switchgear and GIS will be designed such that any leakage of SF6 will trigger an alarm to the nearest concerned O&M location so that staff may immediately rectify any leak. • Provide SF6 leakage detection kit at each substation. • SF6 emergency response plan to be prepared by contractor for construction, NEA in relation to operation to deal with event of an accidental leak.					
Planning for on-site environment, health, and safety management.	Environment, health, and safety impacts and risks of the project during construction in general.	• NEA and Contractor to address all site-specific measures detailed in this EMP with regards biodiversity and physical cultural resources as well as other sensitive receptors before commencing construction works, including any enabling works, ensuring that all pre-construction preparations reflect international engineering best practice/good EHS practices. • Contractor's pre-construction documentation will be reviewed by the PSC to confirm that all measures required by the final EMP have been adequately incorporated and that they reflect international engineering best practice/good EHS practice before they are approved by NEA. • Contractor to prepare and submit a Construction Environmental Management Plan (CEMP) to NEA for approval, for each works package. CEMP to include details on how the Contractor plans to implement the construction mitigation measures specified in the final EMP, and the relevant parts of the IFC EHS General Guidelines including the Construction and Demolition section, and IFC EHS Electric Power Transmission and Distribution Guidelines. The CEMP will also identify the temporary construction facilities needed and their location e.g., laydown and storage areas, workers facilities, etc. • Contractor to keep CEMP as a living document, to be updated as required and re-approved by NEA if any changes in construction methods, site conditions etc.	CEMP and topic- and site-specific sub-plans including CPPP, CWMP, CTMP, BMP, HMP, CFP, CHSMP, CEPRP all prepared and approved prior to any construction works, including enabling works.	PMD to comply with requirements including approval of Contractor's pre-construction documentation, seeking review and comment of other concerned stakeholders as appropriate e.g. for protected areas etc. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements. PMD to ensure checklist of all pre-construction measures is cleared before giving go ahead for works to Contractor.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor. PSC to review Contractor's pre-construction documentation and confirm in accordance with final EMP and reflective of international engineering best practice/good EHS practice. PSC to verify checklist of all pre-construction measures is cleared before NEA gives go	Contractor to comply with requirements prior to any construction works, including enabling works.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

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		Land take: • Ensure relocation and compensation of any affected persons within the ROW has been paid and ensure effective relocation of any households living within the safety clearance corridor (Electricity Rules) has taken place prior to any construction work. **Biodiversity management**: • Contractor to strictly locate all temporary construction facilities outside of forest areas, all temporary workers camps unless within substation boundaries are to be located at least 500 m for forest areas. Location of related project facilities is to be identified by contractor, PSC international biodiversity expert to review if locations are suitable prior to NEA approval. • Include in CEMP or site-specific BMP prohibitions on fishing, hunting, poaching, entering forest land etc. and an emergency fauna rescue and handling procedure, including contacts of forest and protected area management, nearest veterinary etc. **Physical cultural resources management (chance finds)**: • Contractor to strictly locate all temporary construction facilities at least 100m from any identified physical cultural resource e.g., temple. • NEA to develop a Chance Find Procedure (CFP) to be followed by contractor as part of their CEMP prior to commencement of any works, including enabling works, to address the event any physical cultural resources (including fossils) are found during works. CFP is to include the following procedures: o If suspected physical cultural resources are encountered, halt all works at the find site immediately. o The find should be assessed by a competent DOA Official, and procedures to avoid, minimize or mitigate impacts to			ahead for works to Contractor.		

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		such physical cultural resources to be agreed in writing with them. ○ Work will not resume until the procedures to avoid, minimize, or mitigate impacts to the physical cultural resources have been agreed with DOA and confirmed by them in writing to have been implemented in full. ○ If avoidance is not feasible, and no alternatives to removal of the physical cultural resources exist, thorough cost-benefit assessment need to be carried out to assess whether the project works should continue or stop at site. If the project benefits outweigh the anticipated cultural heritage loss from removal from site, following clearance of ADB the physical cultural resources are to be removed and preserved using the best available technique in accordance with relevant national heritage protection laws and regulations as well as international best archeological practice. ○ Records to be maintained of all finds, including chain of custody instructions for movable finds. ○ Construction workers must be made aware of the chance-find procedure and the types of finds (including fossils) to be reported through training and induction before the commencement of any works. **Pollution risk management**: • The Contractor will prepare for NEA approval a construction pollution prevention plan (CPPP) as part of the CEMP covering dust and emissions to air management, noise management, the protection of water resources and environmentally sound and safe storage, use, and disposal of all fuels, chemicals and oils used on site and an emergency preparedness and response plan in the event of any leaks or spills in					

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		accordance with national laws and regulations and the EHS General Guidelines prior to commencement of any works. • The Contractor will prepare for NEA approval a Construction Waste Management Plan (CWMP) as part of the CEMP for dealing with all solid and hazardous waste generated in an environmentally sound and safe manner in accordance with national laws and regulations and the EHS General Guidelines section on Waste Management prior to the start of any works. • Contractor to undertake air quality monitoring per the EMoP (Appendix 10, Table 10.B) to confirm current background levels in the project area at least one week prior to the commencement of any actively on-site. • Plan construction works in the vicinity of waterbodies, considering erosion issues and surface water pollution risk. • If any surface waterbodies or groundwater sources within 100m, Contractor is to undertake a baseline water quality sampling per EMoP (Table 10.B) to confirm their current water quality status at least one week prior to the commencement of any actively on-site. • Contractor to schedule, as far as practical, earthworks at substation sites and installation of towers during the dry season to minimize exposed areas subject to erosion by surface water runoff. • To inform development of the CPPP in relation to noise management, the Contractor will be required to measure and confirm the distance from their construction works to sensitive receptors during the detailed design, to confirm if the noise standards can be met based on their construction methods or temporary acoustic barriers are required. • Contractor to undertake noise monitoring per EMoP (Table 10.B) to confirm current background noise					

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		levels in the project area at least one week prior to the commencement of any actively on-site. • Construction methods to ensure construction noise will be limited to the following as 1 hour LAeq: (i) 70 dB(A) at the site boundary; (ii) at residential properties, 55 (day) and 45 (night) dB(A) in urban areas and 45 (day) and 40 (night) dB(A) in rural areas as defined by Nepal regulations; and (iii) at "peace areas" such as schools as defined by Nepal regulations, 50 (day) and 40 (night) dB(A). • If noise levels may be exceeded, Contractor to erect temporary acoustic barrier around either the noise source and/or site boundary to attenuate noise to level such that noise levels will be met. • For any sites where soil compaction, piling or blasting may be necessary for substation or tower foundations, Contractor to identify properties at risk of vibration damage, undertake a through structural survey, supported by photographic evidence of any properties at risk, and determine whether such buildings may require the installation of vibration monitors during construction to monitor movement. The Contractor will develop a detailed assessment and blasting/piling management plan for approval by NEA addressing both noise and vibration impacts. **Health and safety:** • For each contract package, the Contractor is to undertake a H&S risk assessment through a facilitated workshop to be attended by PMD, PSC and the Contractor during the detailed route survey so that it can inform both the detailed design and pre-construction preparations. H&S risk assessment to consider both occupational and community H&S risks resulting from the construction and operation & maintenance stages of the project. • Informed by the H&S risk assessment, Contractor to prepare a Construction Health and Safety Management Plan (CHSMP) for each package/lot including site-specific measures as needed for each construction site. CHSMP will address both					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		occupational and community H&S risks and adherence to national health, safety labor laws and regulations. Measures reflected in the CHSMP will be in accordance with the EHS General Guidelines sections on Occupational and Community Health and Safety and the Electric Power Transmission and Distribution Guidelines. • Contractor to keep CHSMP as a living document, to be updated as required and re-approved by NEA if any changes in construction methods, site conditions, in response to accident, near miss etc. • In the absence of NEA records to confirm transformers are PCB free (ones installed post-1990 should have records, NEA to facilitate access to data archive) all existing transformers already in-situ must be assumed by the Contractor for health and safety purposes to contain PCBs and if needing to be disturbed by them the oil must be sampled and analyzed following UNEP Guidelines for the Identification of PCB and Materials Containing PCB and a health and safety risk assessment and plan prepared referring to the measures in UNEP (2002) PCB Transformers and Capacitors: From Management to Reclassification and Disposal. Provide workers with training on PCBs and their safe handling and disposal. • Label any equipment or container containing PCBs found in existing transformers and other project equipment and unless being retained in-situ replace it with new PCB free equipment under the project. NEA must ensure appropriate transport, storage, decontamination, and disposal of redundant contaminated units; disposal should involve facilities capable of safely transporting and disposing of hazardous waste containing PCBs. A hazardous waste management plan to be prepared for handling PCBs. • Assess surrounding soil exposed to PCB leakage from equipment removed or retained in-situ and implement appropriate removal and / or remediation.					

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		• CHSMP to include a Construction Emergency Preparedness and Response Plan (CEPRP) including communication systems and protocols to report an emergency situation (health emergency, work-related accident, traffic accident, accident involving the community, natural disaster, fire especially forest fire, virus outbreak etc.). • Contractor to set up an accident reporting system for any health and safety incidents (near miss, minor, lost time, fatal) involving workers or community to be reported to PMD within 24 hours of occurrence with a response plan detailing the incident and how its reoccurrence will be avoided. NEA to then report any lost time or fatal incidents to ADB within 48 hours. Record of all incidents and response taken should include date, time, details of incident, treatment given and outcome, and lessons learnt for the future. • CHSMP and its CEPRP are to be submitted for approval of NEA prior to commencement of any works, including enabling works • In undertaking H&S risk assessment and preparing CHSMP and CEPRP adequate attention will be given to the risks associated with COVID-19 pandemic and other communicable viral diseases. National restrictions for containing the spread of COVID-19 must be complied with and Government of Nepal (https://covid19.mohp.gov.np/) and ADB guidance (https://www.adb.org/publications/safety-well-being-workers-communities-covid-19) is to followed, as well as further guidance detailed in Appendix 8. Contractor will provide adequate sanitation and welfare facilities including hand washing and clean PPE in sufficient quantity are provided on-site and at accommodation; Contractor will also consider the ability of communities to comply with protective measures such as regular handwashing and the local health care facilities' capacity to deal with any infections agreeing with the with nearest Health Center and/or Hospital for emergency cares of workers. Particular attention must be paid to accommodation of workforce given the transient nature of work on transmission lines, to					

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		avoid spreading any virus between communities. CEPRP must include response flow chart and contact details to deal with any construction worker or community member being diagnosed with COVID-19 during the course of the works. To limit contacts and hence contamination risk, the same workers should be grouped in accommodation, transport, and work teams. Medical insurance will be provided by Contractor for all workers with sick leave allowance to ensure symptomatic workers do not attend site; Contractor will avoid no-work-no-pay policies, whereby by fear of not getting paid workers would be tempted to report to work and hide any symptoms, creating more risk for the wider workforce and community. Given the unprecedented nature of responding to COVID-19, public health officials/experts must be consulted in undertaking the risk assessment and management planning for COVID-19. **Traffic management:** • NEA and the Contractor to consult with and seek the agreement of the irrigation authority to use the existing irrigation access roads for the purposes of construction. • For all works on or adjacent to public roads, the Contractor will prepare for NEA approval a Construction Traffic Management Plan (CTMP) appropriate to the pedestrian and vehicular traffic flows on the road as part of the CEMP in consultation with relevant local authorities/traffic police to ensure proper execution of traffic controls including where temporary blockage of the road during installation is required for health and safety purposes and ensure that highly visible guides, advance warning signs or flag persons are in place to direct pedestrian and vehicular traffic.					

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		Damage to crops, structures, and utilities: • Contractor to schedule works affecting agricultural land outside the cropping season. • Contractor to maximize use of existing substation compounds for temporary construction facilities (e.g., laydown and storage areas, workers facilities etc.) • Contractor to locate temporary construction facilities as much as possible on uncultivated land (not natural habitat) to minimize disturbance to cultivated lands. • Contractor to locate temporary construction facilities (e.g., laydown and storage areas, workers facilities etc.) at least 500m away from residential areas/villages within rural areas, at least 500m from surface waterbodies, groundwater wells/springs/water spouts, and 100m from other sensitive receptors (e.g., individual houses, schools, clinics, temples, touristic areas etc.) avoiding land which is steeply sloping or in floodplain/waterlogged. • Construction methods to be selected to minimize risk of damage to roads, utilities, structures, drains etc. • Contractor to plan for using appropriate scaffolding or overhead bamboo frames during stringing works crossing roads, irrigation canals, utilities, structures, or drains to minimize traffic disruption, accident risk, and property damage. • For existing roads, irrigation canals, utilities, structures, drains etc. photographic and/or structural pre-condition surveys are to be completed by the Contractor and agreed with NEA and property owners prior to any works, including enabling works. These must be documented in a pre-project condition report submitted to NEA, which will serve as baseline in case any damage to property occurs • Contractor will be required to restore any property damage that is caused by their works including damage caused by heavy construction traffic using access roads to at least pre-project condition at their own cost. • Contractor to avoid piling or blasting and other vibration inducing activities as much as possible; in locations where this is unavoidable Contractor to					

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		identify properties within the zone of influence and undertake pre-construction structural surveys to identify level of risk. Risk may be high if structures previously damaged during earthquake and not repaired. If risk of structural damage to properties identified due to current condition, consider alternative construction method or temporary relocation of occupants during works if at risk. Consider need to install monitors during construction to monitor structural movement. Structural or cosmetic damage to be repaired by Contractor to at least pre-project condition at their own cost.					
Employment of staff for construction	Temporary employment opportunities, both skilled and non-skilled laborers will be required.	• Contractor to abide by the Nepal Labor Code and labor regulations • Contractor must prohibit child labor (under 18 years old). • Contractor should not discriminate in employment • Contractor should proactively encourage employment from local communities where appropriately skilled. • Contractor should proactively encourage employment of women on the project where appropriately skilled. • GRM will be available to workers for receiving and handling complaints about unfair treatment or unsafe living or working conditions, ensuring no coercion nor reprisal. • Provide health/accident insurance for all workers (formal and informal) for the duration of their contracts. • Contractor to allow a minimum number of sick leave as per Nepal law or 10 days per year, whichever is the higher.	No child labor has been recruited, as per detailed record of employment, and gender/age/origin analysis, provided in monitoring reports.	PMD to comply with requirements throughout project implementation. PMD supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout contract implementation.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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On-site enabling works, construction works, testing and commissioning of project components							
Biological Environment							
On-site pre-construction and construction activities	Impacts on biodiversity including Chure Conservation Area	• Comply with CEMP during construction works • Ensure clear demarcation of the working area and avoid encroachment outside the agreed corridor of impact. • Trees are to be cleared during non-bird breeding season, if this not possible due to weather restrictions on access, trees cleared during breeding season to be checked by field ecologist for nests prior to clearance, if present harvesting to be postponed until the young have fledged. • Unnecessary use of machinery to be avoided to minimize disturbance to fauna. • Revegetate any disturbed areas beyond footprint of substation and tower foundations to at least original condition through revegetation using native species etc. • Construction of new access track is not allowed. Use will be made of existing access roads and tracks for transporting tower materials and machinery, in locations where access is restricted use of manual labor to transport, install and string the towers and lines traversing uncultivated land (not natural habitat) as much as possible to avoid damage to crops • Prior to excavation for tower and substation foundation, area will be checked by a field ecologist for any signs of burrows etc. If determined to be occupied, only manual digging under the supervision of ecologist will be permitted. • Excavated pits will be robustly fenced or covered so as to prevent fauna accidentally falling in, further an escape ramp will be provided to allow their escape – particularly in Chure Conservation Area. • Keep written record, supported by photographs, of any animal casualties, including a cause of death if known. • In wet conditions, minimize use of heavy machinery and consider temporary installation of removable steel plates to protect soil and its vegetation cover.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks, photographic record etc. No outstanding biodiversity-related grievances from local communities.	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout construction	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line Indicative costs for purchase of bird divertors (excluding their installation) and support for the promotion and enhancement or protected areas are included in EMP budget table

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		• Strict prohibition on construction workers to enter forest areas whilst working for the project. • Strict prohibition on purchase, sale, and use of firewood, timber and NTFPs, hunting and poaching of fauna by workers. • Contractor to undertake regular, compulsory awareness raising activities for all workers related to prohibitions including tool box talks, and posting of information and warning signs at site offices, worker camps, patrols by security guards employed by the Contractor, regular inspections of the worker camps, and, disciplinary procedures for any contravention by the workers. • Contractor to provide good standard of worker accommodation with heating and all meals to help discourage breaches of prohibition by the workers. • Strict prohibition of fuelwood or timber being cut by the construction workers. • Contractor and construction workers will be prevented from the use of firewood for cooking their food and heating etc. • Contractor to provide alternative fuel source (e.g. kerosene/LPG, which will be stored in safe conditions) to communal kitchen and for heating of worker accommodation. • Fuel will be stored outside of and refueling will take place close to forest or plantation areas to minimize the risk of fire. • Contractor to provide fire-fighting equipment at work site with compulsory basic fire training for all workers and training drills undertaken in preparation for forest fire. • In case of forest fire, Contractor to act swiftly so as to minimize impacts on the environment and human life. • Remove and dispose of any identified invasive plant species in an ecologically sound manner.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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Physical Environment							
On-site pre-construction and construction activities	Changes in topography/ terrain as a result of earthworks, primarily at substations	• Comply with CEMP during construction works • Contractor to examine stability of tower locations before excavation. • Balance cut and fill in the areas where leveling of sites is required. • Carry out landscaping at each tower location, including bioengineering and slope protection work. • On completion of works re-vegetate disturbed areas to avoid soil erosion. Restore temporarily used sites to at least their pre-project condition following works.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks, photographic record etc. No outstanding topography/ terrain related grievances from local communities.	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line
On-site pre-construction and construction activities	Changes in ambient air quality - dust and suspended particulate matter from earthworks, and other pollutants from vehicular emissions, may affect ambient air quality with impacts on the health of workers and community.	• Comply with CEMP, CPPP, and the IFC EHS General Guidelines in relation to air quality and avoid the occurrence of pollution incidents as far as practicable • Require construction equipment and vehicles to meet national emissions standards, see Appendix 2 of IEE. • Perform regular checks, upkeep, and maintenance of construction equipment and vehicles to keep them in good working order as per the manufacturer's specifications to meet emission standards. Keep log of maintenance undertaken. • Sprinkle water during earthworks to avoid dust being dispersed by wind, cover with materials like gravel to minimize re-suspension of dust. • Stockpiles of spoil and other dust generating materials to be kept to a minimum necessary to undertake works for the day • Cover stockpiles with tarpaulin. Locate stockpiles of loose material at least 500m from residential property to avoid inconvenience to avoid inconvenience from fugitive dust and ensure they are enclosed by a fence	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks, photographic record etc. Monitoring confirms ambient air quality within national standards or no worsening of the baseline situation if already exceeded.	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout construction, keep required maintenance records and undertake ambient air quality monitoring in accordance with the EMoP	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		or similar to minimize windblown dust. Minimize double handling and drop loads. • Trucks importing loose raw materials or removing spoil to local approved disposal sites must be covered with tarpaulin to reduce dust generation, all trucks used are to be serviced and meet Nepal emission standards and belching of black smoke prohibited. • Position any stationary emission sources (e.g., water pumps, diesel generators, compressors, etc.) as far as practical from sensitive receptors (houses, schools, clinics, temples, touristic areas etc.) • Impose speed limits on construction vehicles to minimize exhaust and dust emissions along areas where sensitive receptors are located (houses, schools, clinics, temples, touristic areas etc.). • Trucks transporting loose material will be covered. • Limit engine idling to maximum 5 minutes. • Sprinkle excavations, earthen access road, and material stockpiles with water during the construction period to mitigate dust related issues due to frequent movement of construction vehicles as necessary i.e. 2-3 times per day but more often if needed during excavations, dry and windy conditions that enable dust to be easily mobilized and the dust to be visible. Clean dust from the access road after construction work is completed. • Strictly prohibit the burning of wastes generated by project-related activities. • Ensure workers working in close proximity to or having long exposure to vehicle exhausts and earthworks are provided with clean N95 dust masks to avoid inhalation or particulate matter and other pollutants.	No outstanding air quality-related grievances from local communities or workers.				
On-site pre-construction and construction activities	Changes in ambient noise and vibration levels - mobilization of heavy equipment and machinery, use of construction vehicles, and construction activities	• Comply with CEMP, CPPP, and the IFC EHS General Guidelines in relation to noise and avoid the occurrence of pollution incidents as far as practicable • Schedule construction activities so as to minimize nuisance to sensitive receptors (houses, schools, clinics, temples, touristic areas etc.) i.e., avoid works	Compliance with national laws and regulations. Mitigation measures successfully	PMD to comply with requirements during construction. PMD to supervise and monitor	PSC to supervise, monitor, and assist PMD in ensuring their own	Contractor to comply with requirements throughout construction, keep required	NEA counterpart funds Part of PSC budget

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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	may increase ambient noise level. Exposure to high levels of ambient noise may affect hearing of workers or cause anxiety and disturbance to community.	at night, on weekend, during holidays, school exam periods, etc. • Select construction techniques and low noise generating machinery and equipment e.g. less than 55dBA sound pressure level at 1m, and stage noisy works to limit their duration to minimize noise and vibration • Construction noise must be noise limited to the following as 1 hour LAeq: (i) 70 dB(A) at the site boundary; (ii) at residential properties, 55 (day) and 45 (night) dB(A) in urban areas and 45 (day) and 40 (night) dB(A) in rural areas as defined by Nepal regulations; and (iii) at "peace areas" such as schools as defined by Nepal regulations, 50 (day) and 40 (night) dB(A) – if these levels are exceeded the Contractor will be required to implement additional noise mitigation such as placing temporary acoustic barriers around the works site to ensure that the noise standards are met and/or the construction works do not result in an increase of 3dB(A) above background levels. • Use of piling or blasting and other vibration inducing activities are to be avoided. • Structural or cosmetic damage caused by vibration to be repaired by Contractor to at least pre-project condition at their own cost. • Require construction equipment and vehicles to meet national standards, see Appendix 2 of IEE– all trucks should carry fitness certificates issued by the Nepal Road Traffic Authority and renewed annually under the applicable regulations of Nepal. • Fit all vehicles, machinery and equipment used in construction with exhaust silencers where the manufacturer's design allows this • Perform regular checks and maintenance of construction equipment and vehicles to keep them in good working order as per the manufacturer's specifications to meet emission standards. Keep log of maintenance undertaken. • Position any stationary emission sources (e.g., water pumps, diesel generators, compressors, etc.) as far as	implemented by NEA and Contractor as determined through regular site checks, etc. Monitoring confirms ambient noise within national standards or no worsening of the baseline situation if already exceeded. No outstanding noise or vibration-related grievances from local communities or workers.	contractor to ensure their compliance with delegated requirements.	compliance and assist with supervision and monitoring of the contractor.	maintenance records and undertake noise monitoring in accordance with the EMoP	Part of contract cost, include costs of implementing EMP as BOQ line

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		practical from sensitive receptors (houses, schools, clinics, temples, touristic areas etc.) • Prohibit use of horn by construction vehicles • Limit vehicle movement and offloading of construction materials to daytime in areas where sensitive receptors are located (houses, schools, clinics, temples, touristic areas etc.) transport of materials and spoil by truck will be limited to the daytime without hooting. • Outside of Kathmandu Valley noisy construction activity (especially piling works) will take place between 6 am to 6 pm. Residents will be informed will in advance of the construction schedule for noisy activities. • Impose speed limits on construction vehicles to minimize noise emissions along areas where sensitive receptors are located (houses, schools, clinics, temples, touristic areas etc.). • Limit engine idling to maximum 5 minutes. • Provide appropriate PPE (acoustic ear plugs or earphones capable of reducing noise levels to 80dB(A) for hearing protection) to any workers subjected to noise levels of 80dBA for more than 8hours per day and ensure they wear it e.g. if using breakers. • No unprotected ear should be exposed to a peak sound pressure level (instantaneous) of more than 140 dB(C) or average maximum sound levels of 110dB(A). • Periodic medical hearing checks to be performed on workers exposed to high noise levels.					
On-site pre-construction and construction activities	Changes in quality of surface and groundwater – due to sediment laden runoff or spills/leaks of fuel, oil and chemicals used in construction works.	• Comply with CEMP, CPPP, and the IFC EHS General Guidelines in relation to water quality and avoid the occurrence of pollution incidents as far as practicable. • Follow General EHS Guidelines in relation to water quality for the use and storage of fuel, oil, and chemical including prevention and control of hazards associated with spill prevention, emergency response, spill clean-up and remediation.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and	Contractor to comply with requirements throughout construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		• Establish dedicated fuel, oil, and chemicals stores on impermeable bunded area of 110% volume to avoid spills and leaks contaminating soil and affecting water quality • Avoid storage of fuel, oil, and chemicals in areas within 500m to water sources (surface water and groundwater wells, springs, water spouts etc.) to avoid direct contamination or contamination through run off, if this is not possible minimum distance is to be 100m. • Place all equipment that may leak fuel or oil on drip trays it not sited on impermeable surface with 110% bunded capacity. • Undertake refueling only on areas of hard protected soil, preferably bunded, at least 500m from surface water, but if this is not possible minimum distance to be 100m, with all drainage directed through oil interceptors. • Provide spill response kit with sufficient absorbent materials (e.g. sorbents, dry sand, sandbags) on-site for soaking up any fuel, oil, or chemical leaks/spills. • For transformers, follow the Spill Prevention Control and Countermeasures (SPCC) plan as recommended by United States Institute of Electrical and Electronics Engineer Inc. (IEEE) standard 908. • Undertake construction during the dry season as much as possible to minimize exposed areas subject to erosion by surface water runoff. • Undertake all construction 100m either side of river crossings and in floodplain during the dry season to avoid flood risk, leading to accidents and/or water contamination. • Works over or near watercourses will adopt protection measures to guard against loss of soil that would result in the turbidity of water. • Implement measures to prevent landslides to avoid contamination of rivers by soil. • Minimize soil erosion and surface water runoff by reducing the extent of earthworks, revegetating earthworks on completion, and covering stores of sand and spoil with tarpaulin.	regular site checks, photographic record etc. No outstanding water quality-related grievances from local communities or workers.	with delegated requirements.	monitoring of the contractor.		

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		• Ensure sediment laden runoff shall not discharge directly to surface water but shall be discharged through sedimentation basin and oil interceptor. • If water from excavations is pumped it must either be disposed of to an adjacent defined area of ground for percolation, or to waiting tanker trucks for proper disposal, it must not be disposed of to surface water. • Do not allow washing of equipment or vehicles in surface water and ensure all washing water is discharged to sedimentation basin and oil interceptor instead of directly to surface water. • Cement will be stored in rented private storage facilities; enclosed and not exposed to the elements. • Do not undertake any concrete mixing within 500m of surface water, if this is not possible minimum distance to be 100m. • Provide portable sanitary facilities for construction workers, so as to avoid surface and ground water pollution. Locate these at least 500m away from surface waterbodies including rivers/ponds and groundwater sources including springs/wells/pumps/water spouts, away from floodplain, any waterlogged land and shallow groundwater. • Strict prohibition on open defecation and urination by construction workers; no use of pit latrines for worker camps. • Toilets and washing facilities to be connected to existing sewerage system, septic tank (with soak pit) or as portable self-contained units for disposal of wastewater off site to sewage treatment works. No untreated wastewater is to be discharged direct to surface water or the ground. • Construct adequate drainage with oil interceptors for all new substation sites according to detailed design; install adequate bunding to transformers and storage areas.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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On-site pre-construction and construction activities	Use of raw materials and generation construction waste	• Comply with CWMP and with IFC EHS General Guidelines in relation to waste management. • Import all materials from existing licensed sources and keep records of all materials used, and sources. • Storage yards will be fenced. • Prior to the start of works the contractor will ensure the waste management system is established at the construction sites and workers camps. • Separate waste containers (drums, bins, skips or bags) will be provided for different types of waste. • Sensitize workers on good housekeeping and the environmentally sound storage and disposal of construction and wastes, and importantly not to leave garbage lying around. • Collect and segregate construction wastes including scrap metal, oil, and solid waste; ensure all workers are familiar with this segregation and arrange garbage bins to collect these wastes so they are not thrown on the floor • Store all the wastes produced in an environmentally sound manner in designated, labelled area with separate waste containers (drums, bins, skips or bags) for each distinct type of waste. • Store solid waste in enclosed bins to contain leachate and avoid vermin. • Encourage recovery of recyclable wastes that could be reused or sold to recyclers, rather than disposing of it. • Prohibit use of waste (e.g. empty cement bags and containers, plastic, wooden planks) for backfilling – only inert spoil may be used for backfilling to avoid need for off-site disposal (any excess inert spoil is to be disposed of at suitably licensed waste facilities). • Prohibit burning of construction wastes. • Prohibit dumping of construction wastes on-site, into drains, rivers, in agricultural fields etc. • Provide weekly toolbox talk to remind of the importance of waste disposal, prohibition of disposal on the road, in drains etc., prohibition on burning of wastes, and open defecation and urination. Develop a procedure/system to penalize through escalating	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks, photographic record etc. No outstanding material use or waste-related grievances from local communities or workers. 100% wastes removed off site have been disposed of by licensed waste contractors who reused/recycled or disposed of it to suitably licensed waste management facility, as confirmed by documented full-cycle transfer notes.	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout construction, keep records in accordance with the EMoP	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

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		fines or similar any construction workers who breach these requirements. • Contractor may compost biodegradable kitchen scraps on site if of small volume in enclosed composting facilities (enclosed to avoid attraction of vermin etc.) located ideally 500m but at least 100m from water sources (surface water and groundwater wells, springs, water spouts etc.). • Document all wastes removed off site using transfer notes, to be taken by licensed waste contractors who should reuse/recycle or dispose of the waste to suitably licensed and engineered waste management facilities according to type – for solid waste disposal this will need to be to Kathmandu, and for hazardous waste this will need to be to a neighboring country since no such facilities currently exist in Nepal. • Excavated spoil that cannot be reused to a licensed disposal site as suitable for accepting inert wastes ensuring no solid or hazardous wastes are comingled with the inert excavated spoil • Collect solid waste and dispose of it to suitably engineered and licensed sanitary waste facilities– in Kathmandu as no such facilities are existing in rural municipalities. • Ensure any hazardous waste such as oily rags or old drums disposed of in suitably licensed hazardous waste facilities– out of country since no such facilities in Nepal.					
Socio-economic Impacts							
On-site pre-construction and construction activities	Changes to land use as substation compound and tower footing land is permanently lost and temporary crop loss during installation within the ROW	• Compensate private land required for the project through acquisition or rental in agreement with the land and/or property owners. Permanent land acquisition and crops or private trees lost due to construction will be compensated according to the project Resettlement and Indigenous People Plan. • Phase activities according to the agricultural cycle to allow farmers to harvest standing crops.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and	Contractor to comply with requirements throughout construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

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		• Except for substations as mentioned in the IEE, no construction of access track is allowed, use will be made of existing access roads and tracks for transporting tower materials and machinery, in locations where access is restricted use of manual labor to transport, install and string the towers and lines traversing uncultivated land (not natural habitat) as much as possible to avoid damage to crops • On completion of works restore all temporarily used sites to at least their pre-project condition following works; this will involve cleaning site of any debris or wastes, left over material and soil/rocks/sand, contaminated soil although this should have been avoided through EMP measures; revegetation if required; drainage if required; local topographical adjustments; addition of good quality soil if the latter was eroded/removed by construction works; etc. • Follow detailed design drawings and implement careful construction practices to avoid damage to existing structures (e.g. buildings) and roads, utilities, drains etc. • Contractor to repair and/or compensate for any unforeseen damage to at least pre-project condition in conjunction with relevant local authorities and/or property owner at cost to the contractor • Safe access to property will be maintained and alternative signed routes and access will be provided where there are temporary diversions or blockages. • Locate stockpiles away from properties and only in designated areas where no access will be blocked.	regular site checks, photographic record etc. No outstanding resettlement / economic-displacement / land-related grievances from local communities. 100% of land used for temporary facilities returned to initial condition upon finalization of construction works.	with delegated requirements.	monitoring of the contractor.		Budget for compensation included in Resettlement Plan and Indigenous People
On-site pre-construction and construction activities	Occupational health and safety of workers at risk due to the hazards created during the construction period, e.g. movement of heavy equipment, vehicles, and machineries, working conditions, etc. Workers may be exposed to	• Comply with CHSMP and with IFC EHS General Guidelines in relation to occupational H&S. • Ensure health and safety supervisor is on site at all times (implies an alternate off on leave or on sick). • Require subcontractors and workers to confirm they have seen and understood the requirements of the CHSMP before proceeding with their work. • Provide worker training on H&S and daily/weekly briefings led by site-appointed Health and Safety Officer.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks,	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and	Contractor to comply with requirements throughout construction, maintain records of health and safety incidents per the EMoP and	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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	occupational health risks and safety hazards, regarding site clearance for pre-construction and during construction relating to working with electricity and working at height, as well as from handling PCBs or asbestos in upgrade works at existing substations.	• PPE to be provided for all workers (regardless formal and informal, directly contracted or subcontracted) in accordance with Table 2.7.1. Summary of Recommended Personal Protective Equipment According to Hazard in IFC EHS Guidelines on OHS. • Enforce disciplinary system (e.g. immediate removal from site) for non-compliance with PPE requirements and other H&S measures (e.g. social distancing for COVID-19). • Check health condition of workers on daily basis, for example, use of self-certification forms and temperature checks before being allowed on the construction site with more thorough monthly health checks by qualified medical professional. • Check the load of the vehicles before use, all drivers, and passengers to fasten seatbelt and comply with all transportation-related H&S laws and regulations • Examination of all equipment and tools' quality and the presence of operational safety features before use • Implementation of safety measures while excavating to avoid collapse e.g. shoring if soil unstable • Untrained workers will not be permitted to work with live electricity or at height. • Observe IFC EHS Guideline on Electric Power Transmission and Distribution requirements for working with live power lines; only allow suitably trained workers that meet the requirements set out in above-referred IFC guideline to work on live power lines with strict adherence to safety standards including those listed in said guidelines; these workers must have training record of attending suitable training course on electrical safety and be provided with and wear the appropriate PPE for their role. • Ensure proper grounding and deactivation of any live power lines during construction work or before any work in close proximity to the lines and that this has been checked and certified by the on-site Health and Safety Officer in advance.	photographic record etc. No outstanding OHS related grievances No fatalities or lost time incidents, if they do occur to be reported to NEA board and management within 24h and to ADB within 48h. 100% of H&S incidents including near miss recorded, immediately investigated, and corrective action taken to prevent repeat		monitoring of the contractor. PSC international health and safety expert to work closely with PMD health and safety staff to ensure knowledge transfer and development of knowledgeable health and safety team at NEA.	maintain copies of training records.	Budget for compensation included in Resettlement Plan and Indigenous People

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		• Measure exposure levels to electromagnetic fields (EMF) and provide workers working in zones where EMF levels are above reference levels with personal EMF monitoring device to be attached onto their PPE. • Require workers to observe the minimum approach distances for excavations, tools, vehicles, pruning, and other activities when working around power lines. • Observe IFC EHS Guideline on Electric Power Transmission and Distribution requirements for working at height; only allow suitably trained and qualified workers to work at height, these workers must have training record of attending suitable training course and be provided with and wear the appropriate PPE for their role. Require workers to test the structural integrity of towers prior to proceeding with the work. Use fall protection measures when working on towers, i.e. mobile elevated working platform, and all workers at height are required to wear body harness. Ensure sufficient harnesses and gear are available on site for all workers, that workers are trained to use such harness and are obligated to use the latter at all times when working at height. • Unless transformers have been certified PCB free workers must wear suitable chemical and/or oil resistant gloves, goggles, and protective clothing whilst working with transformers. Eye wash station and water supply to shower to be provided during works due to risk of PCB coming into contact with skin. • Ensure good housekeeping in the premises at all times, including on construction site, workers camps, storage areas, etc. Perimeter is to be kept neat and tidy, with no trip hazards on the ground e.g. open channels, materials, equipment, trash laying around. Do not leave hazardous conditions (e.g. unlit open excavations without means of escape) overnight unless no access by public can be ensured. • During construction works, ensure qualified first aider and trained fire marshal is available on-site at all times with an appropriately equipped first aid kit and					

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		appropriate fire extinguisher and other firefighting equipment immediately available for use. • Provide an ambulance for more serious cases to transport the patient to the hospital for treatment • Prepare signboards reminding of health and safety measures and procedures to follow in case of accident, including key contact details (ambulance, doctor, hospital, etc.) • Keep a log of all incidents, near-misses and accidents and include these in monthly monitoring reports submitted to NEA and periodic monitoring reports to ADB • Temporary construction camps will include proper sanitation, alternative fuel to firewood, clean eating area, water supply, and secure storage of domestic solid wastes for disposal off site to suitably licensed waste management facilities. • Pit latrines prohibited, and adequate number (about 1 toilet per 10 workers, can refer to EBRD guidance note on workers' accommodation) of toilets and washing facility with hot and cold running water. Toilets to be connected to existing sewerage system, septic tank, or as portable self-contained units for disposal of wastewater off site to sewage treatment works to be provided. • Toilets to be equipped with soap and hand sanitizer. • There should be an indication of whether toilet and washing facility is "in use" or "vacant" if not gender segregated. • Toilets should be cleaned at least twice daily to ensure they are kept in a hygienic condition. • Prevent standing water as it may become a breeding habitat for mosquitoes etc. • Provide workers with access to a shaded rest area on-site. • Provide workers with a clean eating area for breaks and lunchtime.					

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		• Provide all construction workers will an adequate supply of potable drinking water meeting national standards. Groundwater used must be appropriately treated and only be used where it will not put stress on local water resources. Where a risk of arsenic contamination is identified, prohibit the use of groundwater as a source of the drinking water. • If ground or surface water is used for drinking water, it must first be tested to confirm it meets drinking water standards and continue to be regularly tested every week. If drinking water standards are not met, potable water shall be imported to site. • If workers are not local to the area use may be made of existing accommodation facilities but if a construction camp is provided it must be adequately equipped with sufficient toilets, hand washing facilities, showers or baths, food preparation and clean eating area, etc.					
On-site pre-construction and construction activities	Community health and safety - at increased H&S risk from communicable diseases as workers coming from elsewhere, including COVID-19, social disturbances related to workers camps, traffic, electricity infrastructure etc.	• Comply with CHSMP and with IFC EHS General Guidelines in relation to community H&S. • Installation of barriers (a temporary fence ideally solid fence) at construction areas with hazard warning signs to deter people from accessing the construction site • Do not leave hazardous conditions (e.g. unfenced and unlit open excavations without means of escape) overnight unless no access by public can be ensured • Define construction schedule for sections along or crossing roads in coordination with local authorities/traffic police particularly where road closures required. • Implement CTMP during construction works with advance warning signs or flag persons to ensure traffic safety of construction workers and road users, in coordination with traffic police. • Road safety and warning signs must be posted at 500m, 100m, and immediately in advance of the works at least two weeks prior to the works	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks, photographic record etc. No outstanding CHS related grievances No project-related accident reported within community - if they do occur to be reported to NEA board	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor. PSC international health and safety expert to work closely with PMD health and safety staff to ensure knowledge	Contractor to comply with requirements throughout construction, maintain records of health and safety incidents per the EMoP.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line Budget for compensation included in Resettlement Plan and Indigenous People

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
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		commencing to inform the public of the temporary blockage. • Access to the construction site will be under traffic controls when trucks enter and exit. • Require all project drivers to abide by Nepal road safety regulations at all times. • Use of scaffold and bamboo frames to support stringing to protect structures, roads, irrigation canals, utilities etc. as well as pedestrians, vehicles, and the conductor itself. • Restore the utilities immediately after all necessary works carried out to minimize public inconvenience • Construction workers including subcontractors will be given awareness raising in HIV/AIDS, other communicable diseases including COVID-19, and sexual, exploitation, abuse and harassment with strict penalties (e.g. immediate removal from site) for any non-compliance of workers to an agreed code of practice • Avoid ponding of water during construction to avoid habitat creation of vector borne diseases e.g. malaria. • Keep a log of all incidents, near-misses and accidents and include these in monthly monitoring reports submitted to NEA and periodic monitoring reports to ADB	and management within 24h and to ADB within 48h. 100% of H&S incidents including near miss recorded, immediately investigated, and corrective action taken to prevent repeat		transfer and development of knowledgeable health and safety team at NEA.		
On-site pre-construction and construction activities	Loss of physical cultural resources (PCR) - chance find procedures will be implemented in case of chance find (including fossils).	• Comply with CEMP and chance find procedure; implement as soon as any monuments or artefacts encountered during construction activities. • Strictly ensure no chance finds are tampered with. • Brief workers on chance find protocol and on apply penalties applying for tempering with them. • Contractor to declare a chance find to DOA and NEA within 24h of find. • PMD to report on any chance find having occurred within 48h to ADB.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through regular site checks,	PMD to comply with requirements during construction. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

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			photographic record etc. No outstanding PCR related grievances 100% of chance finds were reported to DOA and dealt with in accordance with chance find procedure				Budget for compensation included in Resettlement Plan
Operation & Maintenance							
General maintenance	Environment, health, and safety impacts and risks of the project in general	• During maintenance activities, mitigation measures applicable to the construction stage are also applicable to NEA maintenance activities and workers. • Regular visual and technical inspection of condition and maintenance as required to be carried out by NEA daily at substations to check any leaking oil from transformers or any SF6 leak both of which are to be immediately addressed. • Regular visual and technical inspection of condition and maintenance as required to be carried out by NEA quarterly for transmission lines to check: minimum vertical clearance (6.1m) is maintained; integrity of the towers and wires is in good condition, including bird diverters, insulation, anti-climbing devices; electrical safety warning signs and lighting arrestors; missing or corroded parts are immediately identified and replaced; and, any vegetation growth that may damage or threaten the integrity of the lines etc. • Keep photographic records and log of all inspections and actions taken in response.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA as determined through regular site checks, photographic record etc. No outstanding operation & maintenance related grievances Project infrastructure maintained in working order and good condition at all times.	PMD to implement EMP in collaboration with NEA operation & maintenance teams on site.	n/a	n/a	NEA's operational budget.
Biological Environment							
General maintenance of ROW	Impacts on biodiversity including biodiversity supported by Chure Conservation Area	**Protected Areas:** • NEA will continue to implement the promotion/enhancement measures agreed with Chure Conservation Area	Compliance with national laws and regulations.	PMD to implement EMP in collaboration with NEA operation &	n/a	n/a	Indicative costs for reforestation included in EMP budget table.

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		Maintenance and vegetation control: • Regularly visually inspect the lines to spot any low hanging lines to ensure 6.1 m clearance is kept at all times above ground for safe passage of terrestrial fauna and that "bird sensitive" design features including bird divertors have not be lost or damaged, immediately undertake maintenance work if required. • During inspections of transmission lines count fauna carcasses encountered, if any, record species and assess cause of death (e.g., electrocution/collision). • Prohibit the use of herbicides, pesticides or burning to control any vegetation growth or to manage vegetation waste, in substations and along ROW. • Regularly trim trees located within the RoW that are above 5 m high, at least once every two years, following maximum clearance as per Electricity Regulation, 1993 • During maintenance activities, all EMP requirements for construction phase, in particular strict prohibitions on workers are applicable.	Mitigation measures successfully implemented by NEA as determined through regular site checks, photographic record etc. Reforestation resulted in no-net loss of biodiversity as a result of the project. No outstanding biodiversity-related grievances from local communities.	maintenance teams on site.			
Physical Environment							
GIS substations	Climate change from fugitive emission of SF6	• Keep record of all gas insulated switchgear and gas insulated transformers, including presence, if any, and quantity of SF6 in these. • Provide SF6 leakage detection kit at each substation. • NEA to monitor SF6 emissions through inventory control and accounting per the requirements set out in the EMoP to confirm SF6 leakage is kept to an absolute minimum. • Proper handling and storage procedures to be implemented in accordance with equipment suppliers' specifications and best practices. Check for SF6 gas leakage in every shift of the operation. • Maintain SF6 leakage records in every substation and report in periodic monitoring reports to ADB.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA as determined through regular site checks, photographic record etc. SF6 leakage below 0.1% per annum	PMD to implement EMP in collaboration with NEA operation & maintenance teams on site.	n/a	n/a	NEA's operational budget.

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		• Define a safe SF6 retrieval arrangement, with appropriate handling, storage, disposal process for end of life equipment by a certified industrial waste management company who will need to remove SF6 and treat the equipment prior to disposal in accordance international good practice e.g., International Electrotechnical Commission (IEC) standard 61634 to ensure that the SF6 is not released to atmosphere.					
Substation operation	Noise in the form of buzzing or humming can often be heard around transformers or power lines producing corona. Transformer oil spill and leakage.	• Maintain transformers and other noise generating equipment to ensure noise to be limited to the following as 1 hour LAeq: (i) 70 dB(A) at the site boundary; (ii) at residential properties, 55 (day) and 45 (night) dB(A) in urban areas and 45 (day) and 40 (night) dB(A) in rural areas as defined by Nepal regulations; and (iii) at "peace areas" such as schools as defined by Nepal regulations, 50 (day) and 40 (night) dB(A). • Transformers to be routinely inspected and maintained to avoid spills and leakage. • Collect and segregate O&M wastes including scrap metal, oil, and solid waste; ensure all workers are familiar with this segregation. • Store all the wastes produced in an environmentally sound manner in designated, labelled area with separate waste containers (drums, bins, skips or bags) for each distinct type of waste. • Store solid waste in enclosed bins to contain leachate and avoid vermin. • Encourage recovery of recyclable wastes that could be reused or sold to recyclers, rather than disposing of it. • Prohibit open/uncontrolled burning of wastes. • Prohibit dumping of O&M wastes on-site, into drains, rivers, in agricultural fields etc. • NEA may compost biodegradable kitchen scraps on site if of small volume in enclosed composting facilities (enclosed to avoid attraction of vermin etc.) located ideally 500m but at least 100m from water	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA as determined through regular site checks, etc. Monitoring confirms ambient noise within national standards or no worsening of the baseline situation if already exceeded. No outstanding O&M-related grievances from local communities	PMD to implement EMP in collaboration with NEA operation & maintenance teams on site.	n/a	n/a	NEA's operational budget.

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		sources (surface water and groundwater wells, springs, water spouts etc.). • Incineration may be permitted on-site if enclosed, small volume solid waste incinerator with stack and pollution control that is designed for residence time and temperatures that minimize incomplete combustion for waste disposal at substation is available. • Document all wastes removed off site using transfer notes, to be taken by licensed waste contractors who should reuse/recycle or dispose of the waste to suitably licensed and engineered waste management facilities according to type – for solid waste disposal this will need to be to Kathmandu, and for hazardous waste this will need to be to a neighboring country since no such facilities currently exist in Nepal. • Collect solid waste and dispose of it along with municipal waste to suitably engineered and licensed sanitary waste facilities– in Kathmandu as no such facilities are existing in rural municipalities. • Ensure any hazardous waste such as oily rags or old drums disposed of in suitably licensed hazardous waste facilities– out of country since no such facilities in Nepal. • Label all containers with its content and potential risk signs (e.g. flammable, corrosive, toxic, etc.) Display material data sheets for fuels, oil, or chemicals. If chemicals are handled on site, provide an emergency eye wash or shower. • Store end-of-life or unused equipment in designated areas on site, ensure these are not left lying around. • Store equipment in the dedicated, covered, labelled storage area (tools, machinery, material, equipment, and spare parts) • Ensure liquids (fuel, oil, and chemicals, empty drums, old transformers, etc.) are stored in area with impermeable floor with spill containment bund of 110% capacity. • Ensure liquids storage areas are locked at all times.					

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		• Keep track of any maintenance activities carried out with regards to transformers (in particular each time transformer oil is changed) on a maintenance logbook kept on the premises. • Ensure transformers have a label indicating it contains PCB (polychlorinated biphenyl) or is PCB free. Obtain and keep evidence to confirm transformers are PCB free, for future reference. • Perform visual checks of any evidence of oil leaking or having previously leaked from transformers, and if identified, address immediately - maintenance of and handling of transformer oil is to be carried out only by trained workers using appropriate PPE. • Keep spill prevention equipment available on site at all times.					
Socio-economic environment							
Presence of electrical infrastructure and need for maintenance	Occupational safety risks (project maintenance workers) and community safety risks	• Ensure adequate sag and tension always maintained. • Maintain warning / advisory signs in good and visible condition on all dangerous equipment. • Maintain the good condition of non-climb features on transmission towers. • Maintain the good condition of boundary fences, regularly check the security fence for any gaps and repair. Keep boundary gates locked at all times (except when workers are in-coming or exiting) but at times when the gate is unlocked, ensure one staff is always present to control any unauthorized entry. • Consider employing security personnel to guard the premises where the risk of entry for theft might be high. • Carry out periodic safety related awareness raising in neighboring communities regarding living in proximity to power lines and substations, including but not limited to, electrocution risks and effects of EMF; include information to the community regarding potential corona noise heard during operation.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA as determined through regular site checks, photographic record etc. No outstanding H&S related grievances All fatalities reported to government within 24h and to ADB within 48h. No project-related accident reported.	PMD to implement EMP in collaboration with NEA operation & maintenance teams on site.	n/a	n/a	NEA's operational budget.

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		• NEA to ensure all substation staff and maintenance workers have received appropriate OHS trainings for their role **EMF:** • Monitor electromagnetic field strength workers are exposed to and ensure occupational exposures are within the limits of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) reference level. If EMF limits are often reached, provide workers with personal radiation monitors that shall set off an alarm when exposure limits are reached. • Monitor electromagnetic field strength where regularly occupied properties are in the ROW and ensure public exposures are within the reference levels of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines. **Housekeeping:** • Keep the substation neat and tidy at all times. • Remove any trip hazards on the ground, e.g. open channels, materials, equipment, trash laying around. • Carry out regular pest control where pests are a risk; favor natural pest control measures when possible. • Display clear emergency exits signs (in working order, if light signs, ensure works) and keep exits clear of any blockage. • Visually inspect for any standing water on site, and when identified, remove or provide appropriate drainage to remove in timely manner; ensure drainage system is not blocked and fully operational. • Maintain all lights in working order. • Ensure all vents are free of blockages and regularly maintained.					

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		Emergency situations: • Ensure a recent, full, first aid kit and adequate firefighting equipment is available on site at all times, stored in clearly labelled and easily accessible area. • Replace the first aid equipment timely as required to keep all equipment within its expiry date. • Service the firefighting equipment timely as required to keep all equipment in date • Provide first aid and firefighting training to select, volunteer staff; at least one staff having recently carried out first aid and firefighting training must be present on site at all times. Refreshers are to be provided once a year. • Hang posters showing first aid procedures especially for electrocution, and fire procedures, as well as listing all emergency contacts. Display the emergency phone number and location of doctor and hospital in a clear and easily accessible location. • Keep an accident log and make accident logbook available on site upon request. • Monitor closely in case of extreme weather events and be ready to act immediately. • Ensure any buildings on site are structurally sound if any earthquake occurs, check building soundness prior to allowing workers back on site.					
Site-specific EMP							
Kohalpur-Nepalgunj Transmission Line and Nepalgunj Substation	Proximity of physical cultural resources, bird electrocution and collision, presence of Nepalgunj airport, flood risk due to selection of substation site on waterlogged land area, dust due to volume of land fill	• To inform the alignment review NEA and Contractor to consult with communities who utilize Shree Gawat Mata Mandir (Janaki Municipality Ward-5, Bakaspurwa) to seek their views on the routing and reflect their concerns in the detailed design, consultations are to be documented for KNTL • NEA to deliver awareness raising on bird electrocution and collision with power lines and adopting international good practice for “bird sensitive” design to contractor’s staff with design responsibilities. • To minimize electrocution risk, “bird sensitive” design measures will include insulators/isolators between	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through review of pre-construction documentation, regular site checks,	PMD to comply with requirements during detailed design, preconstruction, construction, and operation & maintenance. PMD to supervise and monitor contractor to ensure their compliance	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout detailed design, preconstruction, construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line Indicative costs for purchase of bird divertors (excluding

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		live and earthed components of infrastructure, and between phase conductors, being over 2.7 m horizontally and over 1.8 m vertically, bird guards to prevent perching and nesting by birds, and considering insulating any lower voltage wires and/or jumpers at substation connections. • To minimize collision risk bird divertors, at most 10 m apart, as large as possible, of contrasting colors, and visible at night, will be installed on 10.46 km of earth wire on the Kohalpur-Nepalgunj transmission line. • Required cost for purchase of the bird divertors will be included in the contractor's cost, the contractor will also be required to install them. • Contractor will employ field ecologists during detailed route and topographic surveys of the transmission line and substation. They will perform habitat survey to confirm modified habitat is situated beneath the towers and right of ways in the final alignment; the field ecologists will also record any fauna observed in the project area. • Field Ecologist employed by Contractor to also undertake Sarus crane survey of wards/municipalities in which the OHL will pass during pre-construction to confirm baseline numbers present. • Contractor to site tower footprints to avoid the felling trees, cutting trees in ROW outside tower footprints will be kept to an absolute minimum and only be permitted when it is required for laying and stringing of conductors, to meet safety clearance requirements under the Electricity Rules. • In preference to being cut, trees in ROW that can survive it will be pruned in preference to being cut, such that they might reestablish quicker following works. • Contractor to ensure detailed design of transmission line incorporates lightening protection to minimize fire risks. • Detailed design will have minimum height from ground level 6.1 m sufficient for safe passage fauna	photographic record etc. No outstanding site specific-related grievances from local communities.	with delegated requirements.			their installation) are included in EMP budget table

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		(i.e., the lowest point of a conductor between two adjacent towers to be above 6.1m from the ground) • Contractor's detailed designs and CEMP will be reviewed by the PSC International Biodiversity Specialist to confirm that all the measures required by the IEE/EMP and the international good practice (APLIC, 2006 and 2012) have been adequately incorporated before approval of detailed designs and that the detailed designs have responded to any concerns raised by Bird Conservation Nepal. • For Nepalgunj Substation, NEA to fit any future lower voltage wires and/or jumpers at incoming and outgoing distribution line connections with "bird sensitive" design measures. • For K-N OHL contractor to ensure that the project adopts strict anti-hunting and poaching protocols for workers, undertakes conservation awareness raising activities etc. to minimize risks to priority species and Sarus Crane. • Field Ecologist to specifically check for any presence of pangolin in agricultural fields at K-N before construction to avoid any disturbance to their burrows. • Field Ecologist to specifically check for any presence of nesting Sarus crane in agricultural fields at K-N before construction to avoid any disturbance of the nests, eggs, or chicks, construction during monsoon season to also be avoided as this is their breeding season. • Permission from CAAN will be taken prior to contract award and then once detailed design confirmed the commencement of works and the written communication will be shared with ADB regarding its clearance. • The maximum height of the towers is to be 45m to meet CAAN requirements. Any spherical aviation markers, low-intensity lighting or other mitigation requested by CAAN will be incorporated into the detailed design of these project components.					

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				PMD	PSC	Contractor / Subcontractor	
		• For Nepalgunj Substation, Flood Risk Assessment will be undertaken by the Contractor as part of the detailed design to (i) confirm the extent of flood risk/inundation and thus land filling required, and (ii) determine drainage works that will enable the equivalent volume of storage lost and that surface water runoff from the site is not more than greenfield rates; it will be approved by CEB and shared with ADB. • Particular care will be taken to ensure the condition of the irrigation access road is maintained and it will be included in the scope of pre-construction condition surveys. • Filling for land raising at Nepalgunj substation will only be undertaken during the dry season due to the adjacent canal. • For Nepalgunj substation, the volume of land fill will be calculated and due to the volume of earthworks involved a site-specific Dust Management Plan will be prepared as part of the CEMP to ensure significant impacts will be avoided. • Given the rural location, the more stringent national noise limit must be complied with at residential receptors – 45dBA in the daytime and 40dBA at the nightime • For the transmission line undertake detailed calculations as part of the detailed design process for approval by NEA to confirm that the EMF limits will be complied with.					
Chobar-Lagankhel Underground Transmission Line and upgradation of	Impacts from laying underground line along the road in dense urban area of Kathmandu Valley with crossing of Bagmati River and locally important physical cultural resources	• NEA and Contractor to plan underground cable in conjunction with other construction works in Kathmandu to minimize the cumulative impacts they may cause to the local community. • Transport equipment only during non-rush hours i.e., avoid the hours of 6 am to 8 am and 4 pm to 6 pm.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA	PMD to comply with requirements during detailed design, preconstruction, construction, and operation & maintenance.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and	Contractor to comply with requirements throughout detailed design, preconstruction, construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
Lagankhel Substation		• In Kathmandu Valley noisy construction activity (especially breaking and drilling for underground cables) will take place between 6 am to 6 pm adjacent to residential areas but night time working will be permitted in commercial, tourist and school areas to minimize daytime disruption. • Loud construction noise, breaking activities in particular, must be limited to very short periods of activity adjacent to any given receptor to minimize disturbance. • Contractor to use suitably designed mufflers or sound reduction equipment on breakers and ensure all leaks in the air line are sealed on them. • Local communities will be informed will in advance of the construction schedule for noisy activities. • Construction works for the UG transmission line are to be confined entirely to the existing roadway – no forest land must be impacted and no trees to be cut. • Use horizontal directional drilling as opposed to open trench construction wherever feasible within the built-up area for underground cabling to minimize dust generation. • Contractor to carry out detailed line route survey of alignment of Chobar-Lagankhel UG Transmission Line, including undertaking detailed pre-construction structural survey and photographic record of all property adjacent to the road, in case of any damages claim during laying of cable works. Paying particular attention to weak and sensitive structures along the alignment determine the level of risk and whether such buildings may require the installation of vibration monitors during construction to monitor movement. • Contractor to coordinate with water supply organizations and adopt a suitable construction method where there is greater risk of damage to plastic water pipes. • Contractor to consultant with Department of Roads in relation to the design of the cable installation over the Bagmati Bridge and ensure it does not overload the bridge design.	and Contractor as determined through review of pre-construction documentation, regular site checks, photographic record etc. No outstanding site specific-related grievances from local communities.	PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	assist with supervision and monitoring of the contractor.		of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Special coordination will be necessary with Nepal Traffic Police and pre-information on the planned construction schedule will need to conveyed to them. • For underground cabling adopt a rolling construction method and immediately restore the surface of the excavated roadway once construction activities on each section are completed. • For underground cable alignment, safe access to properties adjacent to the roadway and for informal street vendors will be maintained or, if not possible for health and safety reasons, compensation will be paid in accordance with the RIIP entitlement matrix. • For underground cable alignment, repaving will be done immediately once installation of the cable is complete. • Do not allow the use of oil or bentonite clay as a drilling fluid, if water is used any excess must be disposed of to an adjacent defined area of ground for percolation, or to waiting tanker trucks for proper disposal, it must not be disposed of to surface water. • For works in the Chobar area, the Contractor will develop a site-specific construction method for NEA approval detailing how construction works will factor in the engineering constraints of working in a karst landscape and avoid damage to the karst geology. • For works in the Chobar area, clear demarcation of the working area and avoid encroachment outside the agreed corridor of impact. Natural geological formations adjacent to the working area will also be demarked to avoid accidental damage during construction work. • Crossing of the Chobar Gorge in proposed Pulchocki Conservation Area will ideally be underground within the road or attached the side of the bridge; overhead line is the least preferred option due to electrocution/collision risk – the detailed design and construction method for this crossing is to be determined with the input of DNPWC and BCN.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• If overhead line required at Bagmati River crossing NEA to deliver awareness raising on bird electrocution and collision with power lines and adopting international good practice for "bird sensitive" design to contractor's staff with design responsibilities. • To minimize electrocution risk, "bird sensitive" design measures of any overhead line crossing of the Chobar Gorge will include insulators/isolators between live and earthed components of infrastructure, and between phase conductors, being over 2.7 m horizontally and over 1.8 m vertically, bird guards to prevent perching and nesting by birds, and considering insulating any lower voltage wires and/or jumpers at substation connections. To minimize collision risk bird divertors, at most 10 m apart, as large as possible, of contrasting colors, and visible at night, will be installed. • Required cost for purchase of the bird divertors will be included in the contractor's cost, the contractor will also be required to install them. • Contractor's detailed designs and CEMP will be reviewed by the PSC International Biodiversity Specialist to confirm that all the measures required by the IEE/EMP and the international good practice (APLIC, 2006 and 2012) have been adequately incorporated before approval of detailed designs and that the detailed designs have responded to any concerns raised by Bird Conservation Nepal. • In the proposed Pulchoki Conservation Area, Contractor will not allow any works to be undertaken from 1 hour before sunset to 1 hour after sunrise to avoid disturbance to the fauna, and within 500m of the Bagmati River crossing no noisy works will be undertaken during the bird overwintering period to minimize disturbance to birds. • No lighting is to be used by the Contractor in the proposed Pulchoki Conservation Area. • Contractor to ensure that the project adopt strict anti-hunting and poaching protocols for workers, prohibitions on entry to forest land, undertaking conservation awareness raising activities etc.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Contractor to develop as part of CEMP a site-specific biodiversity management plan (BMP) detailing mitigation and monitoring measures as required for approval by NEA prior to the commencement of any works, including enabling works. BMP will set out how impacts on the proposed protected area and its forest land will be minimized through the detailed design, construction methods, siting of temporary construction facilities, restrictions on construction workers etc. • Contractor to prepare as part of the CEMP Cultural Heritage Protection Plan and individual construction method statements for sections of work adjacent to locally important physical cultural resources for NEA approval prior to the commencement of any works. These will set out how impacts on the physical cultural resources will be minimized through the detailed design, construction methods, siting of temporary construction facilities, restrictions on construction workers etc. • Contractor to appoint one part-time heritage officer for the Chobar-Lagankhel underground transmission line to monitor and supervise works adjacent to locally important physical cultural resources on a full-time basis. • NEA will obtain written approval from the Department of Archaeology on the Chobar-Lagankhel Transmission Line. • NEA to organize third-party support of Department of Archaeology (DOA) officials to monitor and supervise on a full time-basis construction works adjacent to locally important physical cultural resources for their duration to ensure no damage is caused. • Department of Archaeology must be informed of and agree to construction schedule in order that they can facilitate on-site supervision. • Contractor to provide trainings and awareness raising activities for construction workers in relation to					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		informing them of the presence of/avoiding accidental damage to/change finds of physical cultural resources and help NEA liaise with Department of Archaeology and community users. • Contractor will undertake a detailed pre-construction structural and photographic record of all physical cultural resources within 10m of the alignment of UG transmission line. • If physical cultural resources are used by community and access must be restricted to ensure health and safety Contractor to notify affected communities well in advance, and time works to avoid any such restrictions during important festivals etc. • For the Pati/traditional resting place, Saraswathi Temple and old well on the underground cable route alignment near Lagankhel Substation the cable alignment will be routed on the other side of the road to maximize the distance between construction works and these resources. • To inform the alignment review NEA and Contractor to consult with communities who utilize the physical cultural resources within at least 50m of the transmission line to seek their views on the routing and reflect their concerns in the detailed design, all consultations are to be documented. • For underground cables place warning marks above ground or over the cable to avoid others digging into the underground cable which can result in cable break incidents. • NEA to share the information of the routing of all underground cables to the relevant authorities so when underground works need to be done by others, the location of the cables would be known and can plan to be avoided by their contactors. • Detailed design for underground transmission line to include protection relays in the substation to detect a break in the cable armor and stop sending electricity immediately by automatically opening switchgear in the substation to minimize the risk of live shock.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Use of trenchless technology for underground cables to substantially minimize traffic congestion and disruption and disturbance to livelihoods, residences, businesses, and community facilities. • Ensure safe access to property and roads/sidewalks is maintained wherever possible by provision of checkered steel plates or stone slabs and diversions and alternative access provided and clearly signed where there are temporary blockages that are a health and safety risk. • Safety guides should be provided where works are on sidewalks or in locations of pedestrian crossings to help guide pedestrians, especially vulnerable persons, safely around the working area. • For road blockages flag men are to be utilized during works to control the traffic flow and protect construction workers and the road users. • Avoid rush hour (6am to 8 am, and 4pm to 6 pm) where works affect roads and sidewalks. • Stockpiling of spoil and cable reels shall be away from properties and only in designated areas where no access will be blocked. • Contractor to identify in consultation with service providers appropriate measures to minimize period of disruption to utilities and reduce health and safety risks during installation. • If services must be disrupted Contractor (via service providers if appropriate) to notify affected communities well in advance of any power outage etc. • The Contractor will act in accordance with the agreed site-specific EMP, BMP, Heritage Protection Plan etc. • NEA to suspend the Contractor's works if needed due to an unanticipated impact/risk or non-compliance with requirements until corrective action is taken to address this; the Contractor must immediately stop work if requested by Department of Archaeology and before resuming works agree and implement					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		appropriate corrective action for dealing with unanticipated impact or non-compliance with NEA. • Contractor's environment safeguard team to oversee all activities on this component with Contractor engaging security to ensure workers do not engage in prohibited activities. • Contractor will be responsible for repairing at their costs any damage to utilities, roads, and structures prior to completion of their contract. • Contractor will be responsible for repairing at their cost any damage to physical cultural resources within 10 m distance from the UG transmission line. Repairs to would need to be undertaken under the instruction of Department of Archaeology by appropriately qualified and experienced restoration contractors using appropriate materials and construction techniques etc.					
Chobar-Lagankhel Underground Transmission Line and upgradation of Lagankhel Substation	Environment, health, and safety impacts and risks related to existing facilities i.e., Lagankhel substation	• Ensure that the IEE and EMP for PTDEEP Project (Loan 3542) are updated to incorporate Chobar Substation, cleared by ADB, and disclosed, and that works at Chobar Substation are then undertaken in accordance with its EMP. • NEA to implement the project-level Corrective Action Plan (CAP) set out in Appendix 3 of the IEE for existing facility and ensure that prior to start of work by the contractor at Lagankhel Substation all existing facilities meet national laws and regulations and are consistent with the SPS requirements. On completion of corrective actions by NEA, PSC to revisit substation to confirm the status. • PSC to submit a report, including photos, on the status of corrective actions, compliance with national laws and regulations, and consistency with SPS requirements to ADB for clearance, NEA must receive ADB clearance of this report before contractor given access to a substation. • If asbestos is identified by NEA, PSC or Contractor but does not need to be disrupted and appears in good condition, consider leaving it where it is, as main health risks occur when asbestos is moved.	Existing facility meet national laws and regulations and are consistent with the SPS requirements prior to contractor being given access to substation site. Report on the successful completion of CAP cleared by ADB prior to contractor being given access to substation site.	PMD to comply with requirement to implement CAP prior to allowing Contractor access to existing substation site.	PSC to supervise, monitor, and assist PMD in ensuring compliance with CAP including preparation on-site verification and reporting	n/a	NEA budget as per CAP in Appendix 3 Part of PSC budget

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• If any asbestos was found to be present and it will be disturbed by construction works, it must be removed following national requirements and international good practice per EHS General Guidelines on OHS and disposed of as hazardous waste material. • For Lagankhel Substation, NEA will remove all used substation equipment from the extension area and document its disposal using transfer notes, it is to be taken by licensed waste contractors who should reuse/recycle or dispose of the waste to suitably licensed and engineered waste management facilities according to type – for solid waste disposal this will need to be to Kathmandu, and for hazardous waste this will need to be to a neighboring country since no such facilities currently exist in Nepal. • For Lagankhel Substation, the Contractor will undertake a detailed contaminated land site investigation of the extension area including soil quality testing from across the upgrade site to determine if soil contamination is present. If it is the Contractor will prepare for NEA approval a contaminated land remediation plan to either clean the soil before reuse or for its removal off site as a hazardous waste.					
Dumkibas Substation	Substation located with Chure Conservation Area, noise levels due to proximity of residential properties	• NEA to continue to consult with and secure written confirmation from the Chure Conservation Area with specific reference to the substation proposals as to (i) actions required to ensure works are in accordance with their management plans and (ii) measures NEA can support to promote and enhance their conservation aims. • NEA will implement the promotion/enhancement measures agreed with the protected area management in parallel with construction works. • NEA will not award any contract for Dumkibas substation until ADB SPS (2009) protected area management requirements have been confirmed as met by ADB.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through review of pre-construction documentation, regular site checks, photographic record etc.	PMD to comply with requirements during detailed design, preconstruction, construction, and operation & maintenance. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout detailed design, preconstruction, construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• NEA and the Contractor will continuously liaise with the protected area management of Chure Conservation Area to keep them informed of progress on construction. • NEA to deliver awareness raising on bird electrocution and collision with power lines and adopting international good practice for "bird sensitive" design to contractor's staff with design responsibilities. • To minimize electrocution risk, "bird sensitive" design measures will include insulators/isolators between live and earthed components of infrastructure, bird guards to prevent perching and nesting by birds, and considering insulating any lower voltage wires and/or jumpers at substation connections. • Contractor's detailed designs and CEMP will be reviewed by the PSC International Biodiversity Specialist to confirm that all the measures required by the IEE/EMP and the international good practice (APLIC, 2006 and 2012) have been adequately incorporated before approval of detailed designs and that the detailed designs have responded to any concerns raised by Bird Conservation Nepal. • For Dumkibas Substation, NEA to fit any future lower voltage wires and/or jumpers at incoming and outgoing distribution line connections with "bird sensitive" design measures. • Field Ecologist to specifically check for any presence of pangolin in agricultural fields at Dumkibas before construction to avoid any disturbance to their burrows. • For Dumkibas, contractor to ensure that the project adopts strict anti-hunting and poaching protocols for workers, restricts access to the adjacent forest land, undertaking conservation awareness raising activities etc. to minimize risks to forest habitat and priority species. • Construction works including temporary construction facilities are to be confined to agricultural land and within the boundaries of the proposed substation, no encroachment on forest area.	No outstanding site specific-related grievances from local communities.				

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Contractor will not allow any works to be undertaken from 1 hour before sunset to 1 hour after sunrise to avoid disturbance to the fauna. • No lighting is to be used by the Contractor in Chure Conservation Area. • Detailed design will need to include firefighting provision at substation with development of emergency response plan with basic fire training and training drills undertaken for substation staff in event of forest fire. • Contractor to coordinate with DFO and community forest user groups for definition of additional measures for inclusion in the Construction Emergency Preparedness and Response Plan for Dumkibas Substation where works are to be carried out in proximity (within 500m of) to forested areas and there is risk of forest fire to plan for. • Contractor to develop as part of CEMP a site-specific biodiversity management plan (BMP) detailing mitigation and monitoring measures as required for approval by NEA prior to the commencement of any works, including enabling works. BMP will set out how impacts on the protected area will be minimized through the detailed design, construction methods, siting of temporary construction facilities, restrictions on construction workers etc. • The Contractor will act in accordance with the agreed site-specific EMP and BMP as well as in manner consistent with the protected area management plan. • NEA to suspend the Contractor's works if needed due to an unanticipated impact/risk or non-compliance with requirements until corrective action is taken to address this. • Contractor's environment safeguard team to oversee all activities in Chure Conservation Area with Contractor engaging security to ensure workers do not engage in prohibited activities.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Contractor's environment officer for monitoring and supervision at Dumkibas substation is to have an ecological background given the location in Chure Conservation Area. • For Dumkibas Substation the contractor's Environment Officer will help liaise with the protected area management, and support implementation of promotion/enhancement measures agreed with them. • Prior to connecting the substation to the Bardhaghat-Sardi 132 kV DC transmission line, NEA will obtain written confirmation from MEWRI, Department of Forests, and the President Chure Terai Madhesh Conservation Development Board all requisite national environmental clearance requirements have been complied with. • For Dumkibas substation the more stringent national noise limit must be complied with at residential receptors – 45dBA in the daytime and 40dBA at the night time. • Infrastructure and thus the construction footprint must be set back as far as possible from the site boundaries adjacent to properties, ideally at least 50m. • A sufficiently tall, engineered acoustic barrier must be installed around the boundary of the substation site prior to the commencement of any works including site preparation, this may be temporary structure for construction to ensure noise limits are complied with at the receptors. • Permanent engineered acoustic barrier of sufficient height will need to be incorporated into the detailed design and installed prior to operation, due to the proximity of the residential properties within 15m to ensure noise limits are complied with at the receptors. • Reinforcement of gravel access road to Dumkibas will be undertaken only within its existing footprint whilst still facilitating safe use of the access road by the local community.					

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Information on construction method and schedule will be shared with neighboring household regarding prior to commencement of works.					
Mulpani Substation	Vibration, Noise and damage to neighboring structures	• NEA and the Contractor will ensure that during detailed design a safe and well-constructed access will be provided to the houses which are affected by the land take required for the substation construction, the access design will be determined in consultation with the residents and their agreement obtained in writing before the detailed designs for the substation are approved. • The Contractor will undertake a noise and vibration assessment as part of the detailed design stage and prepare a management plan as part of the CEMP for soil compaction and/or piling activities demonstrating how the construction noise requirements will be met (e.g., 70dBA at site boundary, 55dBA day and 45dBA night at residential receptors) and property damage as a result of any vibration due to compaction will be avoided and monitored. • Infrastructure and thus the construction footprint must be set back as far as possible from the site boundaries adjacent to properties, ideally at least 50m. • Ensuring safe distance to the neighboring houses are kept from the piling locations within the substation premises. • A sufficiently high engineered acoustic barrier must be installed around the boundary of the substation site prior to the commencement of any works including site preparation, this may be temporary structure for construction to ensure that noise limits are met at the receptors.	Compliance with national laws and regulations. Mitigation measures successfully implemented by NEA and Contractor as determined through review of pre-construction documentation, regular site checks, photographic record etc. No outstanding site specific-related grievances from local communities.	PMD to comply with requirements during detailed design, preconstruction, construction, and operation & maintenance. PMD to supervise and monitor contractor to ensure their compliance with delegated requirements.	PSC to supervise, monitor, and assist PMD in ensuring their own compliance and assist with supervision and monitoring of the contractor.	Contractor to comply with requirements throughout detailed design, preconstruction, construction.	NEA counterpart funds Part of PSC budget Part of contract cost, include costs of implementing EMP as BOQ line

Project component or activity	Impact or risk to be mitigated	Mitigation measure(s)	Performance indicators	Institutional responsibilities (including implementation, supervision, and monitoring)			Budget/source
				PMD	PSC	Contractor / Subcontractor	
		• Permanent engineered acoustic barrier of adequate height will need to be incorporated into the detailed design and installed prior to operation, due to the proximity of the residential properties to ensure noise limits are complied with. • Contractor to identify properties around substation site which are at risk of vibration damage, undertake a through structural survey, supported by photographic evidence of any properties at risk, and determine whether such buildings may require the installation of vibration monitors during construction to monitor movement. • Information on construction method and schedule will be shared with neighboring household regarding prior to commencement of works. • Any structural damage to the neighboring houses caused by the construction works will be compensated. • Ground works will ensure coordination with the neighboring households on disruption of any utility such as power, water supply etc.					

Table 10.B: Minimum Provision for Quantitative Environmental Monitoring (EMoP)

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Detailed design and pre-construction preparations								
Air quality: SPM, PM10, PM2.5, SO2, and NO2	Nearest receptor within 100m of substations. Sample of one representative location along Kohalpur-Nepalgunj transmission line. Sample of three representative locations along Chobar-Lagankhel UG transmission line.	One time for baseline establishment prior to the start of any activity on site	To be measured as 1-hour and 24-hour averages along with meteorological data- temperature humidity, wind speed, and wind direction-over a fortnight during dry season.	No exceedance of national ambient air quality standards (or no worsening if exceeded) at sensitive receptors	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report to PMD.	Professional, calibrated, portable outdoor air quality monitoring sensors Part of contract cost, include costs of implementing EMP as BOQ line
Noise level: dB(A)	Site boundary and nearest receptor within 100m of substations. Sample of one representative location along Kohalpur-Nepalgunj transmission line. Sample of three representative locations along Chobar-Lagankhel UG transmission line.	One time for baseline establishment prior to the start of any activity on site	1hr LAeq over a 48-hour period including workday and weekend using professional, calibrated portable monitoring devices.	No exceedance noise standards specified in Table 10.A (or less than 3dBA increase if already exceeded) at site boundary and sensitive receptors	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report to PMD.	Portable real-time calibrated decibel (dB) meter Part of contract cost, include costs of implementing EMP as BOQ line

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Water quality	Surface waterbodies or groundwater sources within 100m	One time for baseline establishment prior to the start of any activity on site	Water sample is to be taken in a clean, non-contaminated, well-sealed container and tested within the next 48h. Water quality tests by accredited laboratory (physical, chemical, and bacteriological tests) to include pH, turbidity, color, TSS, DO, BOD, TPH, fecal coliform. If used as source of drinking water to also test against Nepal drinking water standards	No pollution incident affected surface or groundwater quality	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line
PCBs	All transformers for which documentation confirming PCB-status is not available from NEA.	Once at the onset of project, no additional impact as all equipment and oil procured will be PCB-free	Testing of transformer oil should follow UNEP Guidelines for PCB-testing	All existing substation transformers PCB-free	PMD to recruit licensed entity for testing and report quarterly to ADB	PSC to assist PMD in ensuring that testing is carried out	n/a	To be included in third party bid, around $100 per sample plus costs of collecting the samples
Soil quality	Lagankhel Substation	One time for baseline establishment prior to the start of any activity on site	Soil samples to be taken from across the extension area in a clean, non-contaminated, well-sealed container and tested within the next 48h. Soil quality tests by accredited laboratory to include pH, heavy metals, TPH and PCBs.	No soil contamination or any present remediated prior to construction works	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line
Health and Safety/Physical Cultural Resources: condition surveys in relation to property damage including due to noise and vibration	All properties/ physical cultural resources along transmission lines and adjacent to substations requiring condition survey as per Table 10.A	One time for baseline establishment	Photographic and/or structural pre-condition surveys of existing property condition including roads, irrigation canals, utilities, structures, drains etc. Risk assessment of potential damage to structures and additional recommendations for monitoring were there is a risk of property damage	Damages avoided but if caused paid for by contractor National Building Code to be referred to	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake surveys and report to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Health and Safety: drinking water supplies	Substations	One time for baseline establishment to inform detailed design	Water sample is to be taken in a clean, non-contaminated, well-sealed container and tested within the next 48h. Drinking water quality tests against Nepal drinking water standards by accredited laboratory (physical, chemical, and bacteriological tests including arsenic levels)	Drinking water provided meets national drinking water standards	PMD to appoint third-party laboratory to undertake testing and report results semi-annually to ADB	n/a	n/a	Budget around $200 per sample for third-party laboratory testing
On-site enabling works, construction works, testing and commissioning of project components								
Air quality: SPM, PM10, PM2.5, SO2, and NO2	Nearest receptor within 100m of substations. Sample of three representative locations along Chobar-Lagankhel UG transmission line; additional locations at request PMD/PSC in event visible dust pollution or grievance received during construction	Once during active construction involving earthworks, and then as requested by PMD/PSC in event of visible dust pollution or grievance received during construction.	To be measured as 1-hour and 24-hour averages along with meteorological data- temperature humidity, wind speed, and wind direction-over a fortnight during dry season.	No exceedance of national ambient air quality standards (or no worsening if exceeded) at sensitive receptors	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report monthly to PMD.	Professional, calibrated, portable outdoor air quality monitoring sensors Part of contract cost, include costs of implementing EMP as BOQ line

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Noise level: dB(A)	Site boundary and nearest receptor within 100m of substations. Sample of three representative locations along Chobar-Lagankhel UG transmission line; additional locations at request PMD/PSC in event noise pollution concerns or grievance received during construction	Once during active construction involving noisy activities, and then as requested by PMD/PSC in event of noise pollution concerns or grievance received during construction.	1hr LAeq over a 48-hour period including workday and weekend using professional, calibrated portable monitoring devices.	No exceedance noise standards specified in Table 10.A (or less than 3dBA increase if already exceeded) at site boundary and sensitive receptors	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report monthly to PMD.	Portable real-time calibrated decibel (dB) meter Part of contract cost, include costs of implementing EMP as BOQ line
Water quality	Surface waterbodies or groundwater sources within 100m	Only required if requested by PMD/PSC in event water pollution concerns or grievance received during construction.	Water sample is to be taken in a clean, non-contaminated, well-sealed container and tested within the next 48h. Water quality tests by accredited laboratory (physical, chemical, and bacteriological tests) to include pH, turbidity, color, TSS, DO, BOD, fecal coliform. If used as source of drinking water to also test against Nepal drinking water standards	No pollution incident affected surface or groundwater quality	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake measurements and report monthly to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line
Construction materials and waste management: record keeping	All construction sites, including construction camps	Monthly reporting by contractor	Keep records of all types of materials used and wastes produced by type, volume/weight. Document waste handling full-cycle through transfer notes (including type, volume, source, transport, intermediaries if any and final treatment or disposal facility (with its license and capacity)	Transfer of all construction wastes documented, and all wastes disposed of in an environmentally sound manner in accordance with IFC EHS Guidelines and agreed CWMP.	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to keep records and report monthly to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Occupational and community health and safety incidents: record keeping	All construction sites, including construction camps	Monthly reporting by contractor	Keep records of near miss, minor, lost time, and fatal health and safety incidents related to the project, compile records from construction sites; carry out interviews with workers and the community to identify if any unrecorded incidents occurred During the COVID-19 pandemic, temperature checks to be carried out at entrance of the work site at start of shift, and records of all suspected and confirmed cases to be kept.	Zero lost time incidents or fatalities (among workers and community) All near miss, minor, lost time, and fatal incidents as well as suspected/confirmed COVID-19 instances having adequate response plan, with lessons learnt for future if they occur.	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake monitoring and report monthly to PMD.	For COVID-temperature checks frontal thermometer. Part of contract cost, include costs of implementing EMP as BOQ line
Health and Safety: drinking water supplies	Construction camps	Monthly reporting by contractor	Water sample is to be taken in a clean, non-contaminated, well-sealed container and tested within the next 48h. Drinking water quality tests against Nepal drinking water standards by accredited laboratory (physical, chemical, and bacteriological tests including arsenic levels) Alternatively, evidence that drinking water meeting national standards is being imported for workers consumption is to be provided	Drinking water provided meets national drinking water standards	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake monitoring and report monthly to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line Budget around $200 per sample for third-party laboratory testing
Health and Safety/Physical Cultural Resources: condition surveys in relation to property damage including due to noise and vibration	All properties/ physical cultural resources along transmission lines and adjacent to substations requiring condition survey as per Table 10.A	Monthly reporting by contractor	Ongoing photographic record of the condition of roads, irrigation canals, utilities, structures, drains etc. Structural condition monitoring of properties at risk as recommended from the pre-construction surveys	Damages avoided but if caused paid for by contractor National Building Code to be referred to	PMD to supervise contractor and to report quarterly to ADB	PSC to assist PMD in supervision	Contractor to undertake surveys and report to PMD.	Part of contract cost, include costs of implementing EMP as BOQ line

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Operation & Maintenance								
GHG emissions: SF6 leakage	All GIS substations	Daily, as part of daily shift checks.	Record of all SF6 leakage and any SF6-related maintenance activities in GIS substations.	Leakage <0.1% and records of undertaking a regular maintenance	PMD (supported by third party if needed) to undertake monitoring and report semi-annually to ADB.	n/a	n/a	Portable SF6 leakage detector - one per site (around $100 each)
Noise level: dB(A)	Site boundary and nearest receptor within 100m of substations.	Once at the completion of construction	1hr LAeq over a 48-hour period including workday and weekend using professional, calibrated portable monitoring devices.	No exceedance noise standards specified in Table 10.A (or less than 3dBA increase if already exceeded) at site boundary and sensitive receptors	PMD (supported by third party if needed) to undertake monitoring and report semi-annually to ADB.	n/a	n/a	Portable real-time calibrated decibel (dB) meter ($1000 per site)
Health and Safety: accident records	For all project components	Monthly	Keep records of health and safety incidents, compile records from substations and carry out interviews with workers and the community to identify if any unrecorded incidents occurred	Zero lost time incidents or fatalities (among workers and community) All near miss, minor, lost time, and fatal incidents having adequate response plan, with lessons learnt for future.	PMD to keep accident records and report semi-annually to ADB, report any lost time incident or fatality within 48h to ADB	n/a	n/a	NEA operational budget

Environmental Parameters to be Monitored	Location	Time / Frequency / Duration	Methods of measurements	Performance Standard / quantitative targets	Institutional responsibilities (including implementation, supervision, and monitoring)			Equipment and Costs
					PMD	PSC	Contractor / Subcontractors	
Health and Safety: electromagnetic field (EMF)	Overhead transmission lines with regularly occupied properties in ROW Substations	Once at the completion of construction at transmission lines. Daily monitoring for workers at substations working in close contact EMF.	EMF spot checks along length of transmission lines at locations with regularly occupied properties in ROW Continuous check for substation workers working in close contact with EMF, through personal EMF monitor carried by worker at all times while working on live equipment.	No exceedance of ICNIRP reference levels	PMD (supported by third party if needed) to undertake monitoring and report semi-annually to ADB.	n/a	n/a	Portable site EMF detector, personal EMF radiation exposure monitoring equipment for workers (around $100 each)
Health and Safety: drinking water supplies	Substations	Once at the completion of construction, then annually retest.	Drinking water quality tests against Nepal drinking water standards by accredited laboratory (physical, chemical, and bacteriological tests including arsenic levels) Alternatively, evidence that drinking water meeting national standards is being imported for workers consumption is to be provided	Drinking water provided meets national drinking water standards	PMD to appoint third-party laboratory to undertake testing and report results semi-annually to ADB	n/a	n/a	Budget around $200 per sample for third-party laboratory testing

CHAPTER 2- GENERAL TECHNICAL REQUIREMENT

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1.0 FOREWORD

1.1 The provisions under this chapter are intended to supplement general requirements for the materials, equipments and services covered under other chapters of tender documents and is not exclusive.

2.0 GENERAL REQUIREMENT

2.1 The contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification during detailed engineering.

2.2 It is recognized that the Contractor may have standardized on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to Purchaser.

2.3 Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification and bid price schedule but which are necessary for commissioning and satisfactory operation of the switchyard/substation unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided, shall be inter-changeable with one another.

3.0 STANDARDS

3.1 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of Nepal/relevant IEC standard or Acceptable International Standard.

3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standard specified under Annexure-A of this chapter, unless specifically mentioned in the specification.

3.3 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.

3.4 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IEC or equivalent international standard.

3.5 When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

3.6 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Annexure-A / individual chapters for various equipments shall also, be accepted, however the salient points of difference shall be clearly brought out in the Additional information schedule of the bid along with English language version of such standard. The equipment conforming to standards other than specified under Annexure-A/

individual chapters for various equipments shall be subject to Purchaser's approval.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

4.1 The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions.

4.2 All equipments shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.

4.3 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.

4.4 The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.

4.5 The equipment shall also comply to the following:

a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".

b) All piping, if any between equipment control cabinet/ operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

4.6 Equipments and system shall be designed to meet the following major technical parameters as brought out hereunder.

4.6.1 System Parameter

220kV System(Not Applicable)

SL No	Description of parameters	220 kV System
1.	System operating voltage	220kV
2.	Maximum operating voltage of the system(rms)	245kV
3.	Rated frequency	50Hz
4.	No. of phase	3
5.		
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	1050 kVp
ii)	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	-
iii)	One minute power frequency dry withstand voltage (rms)	-
iv)	One minute power frequency dry and wet withstand voltage (rms)	460kV
6.	Corona extinction voltage	156kV
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 156kV rms for 220kV system	1000 micro-volt
8.	Minimum creepage distance (25mm/kV)	6125 mm
9.		
i.	Phase to phase	2100 mm

SL No	Description of parameters	220 kV System
ii.	Phase to earth	2100 mm
iii)	Sectional clearances	5000 mm
10.	Rated short circuit current for 1 sec. duration	40kA
11.	System neutral earthing	Effectively earthed

132kV, 66 kV & 11kV System

SL No	Description of parameters	132 kV System	66 kV System	11 kV System
1.	System operating voltage	132kV	66kV	11kV
2.	Maximum operating voltage of the system(rms	145kV	72kV	12kV
3.	Rated frequency	50Hz	50Hz	50Hz
4.	No. of phase	3	3	3
5.	Rated Insulation levels			
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	650 kVp	325 kVp	75 kVp
ii)	One minute power frequency dry and wet withstand voltage (rms)	275kV	140kV	28kV
6.	Corona extinction voltage	105kV	-	-
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 92KV rms for 132KV system	500 micro-volt	-	-
8.	Minimum creepage distance (25mm/kV)	3625 mm	1800 mm	300 mm
9.	Min. Clearances			
i.	Phase to phase	1300 mm	1300 mm	280 mm
ii.	Phase to earth	1300 mm	13000 mm	140 mm
iii)	Sectional clearances	4000 mm	3500 mm	3000 mm
10.	Rated short circuit current	31.5 kA for 1 Sec	31.5 kA for 1 Sec	25 kA for 3 Sec
11.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed

Note :

1. The above parameters are applicable for installations up to an altitude of 1000m above mean sea level. For altitude exceeding 1000m, necessary altitude correction factor shall be applicable.
2. The insulation and RIV levels of the equipments shall be as per values given in the respective chapter of the equipments.

4.6.2 Major technical parameters of bushings / hollow column / support insulators are given below:

220kV System(Not Applicable)

S.N.	Parameters	**220 kV**
(a)	Max. System voltage Um(kV)	245
(b)	Impulse withstand voltage (dry & wet) (kVp)	± 1050
(c)	Power frequency withstand voltage (dry and wet) (kV rms)	460
(d)	Total creepage distance (min) (mm)	6125

The requirement of alternate long & short sheds stated in model technical specification shall not be applicable in case of 11 kV.

132kV, 66kV & 11kV System

S.N.	Parameters	**132 kV**	**66kV**	**11kV**
(a)	Max. System voltage Um(kV)	145	72	12
(b)	Impulse withstand voltage (dry & wet) (kVp)	± 650	± 325	± 74
(c)	Power frequency withstand voltage (dry and wet) (kV rms)	275	140	28
(d)	Total creepage distance (min) (mm)	3625	1800	300

4.6.3 Major Technical Parameters

The major technical parameters of the equipments are given below. For other parameters and features respective technical chapters should be referred.

4.6.3.1

(A) For 245 kV & 145 kV Equipments

Rated voltage kV (rms)	245	145
Rated frequency (Hz)	50	50
No. of Poles	3	3
Design ambient temperature (°C)	50	50

Rated insulation levels :

1) Full wave impulse withstand voltage (1.2/50 micro sec.)

-	between line terminals and ground	± 1050 kVp	±650 kVp
-	between terminals with circuit breaker open	± 1050 kVp	±650 kVp

-	between terminals with isolator open	± 1200 kVp	±750 kVp

2) One minute power frequency dry and wet withstand voltage

-	between line terminals and ground	460 kV (rms)	275 kV (rms)
-	between terminals with circuit breaker open	460 kV (rms)	275 kV (rms)
-	between terminals with Isolator open	530 kV (rms)	315kV (rms)

Max. radio interference voltage (microvolts) for frequency between 0.5 MHz and 2 MHz in all positions of the equipments.	1000 (at 156 kV rms)	500 (at 92 kV rms)

Minimum creepage distance :-

Phase to ground (mm)	6125	3625
Between CB Terminals (mm)	6125	3625
System neutral earthing	Effectively earthed	Effectively earthed
Seismic acceleration	- 0.5g horizontal -	
Rating of Auxiliary Contacts	10 A at 220/110 V DC (as applicable)	
Breaking capacity of Auxiliary Contacts	2 A DC with circuit time constant of not less than 20ms.	
Phase to phase spacing (mm)	4500 or 4000	3000 or 2700

Auxiliary Switch shall also comply with other clauses of this chapter.

(B) FOR 245 kV & 145 kV CT/CVT/SA

Rated voltage kV (rms)	245	145
Rated frequency (Hz)	50	50
No. of poles	1	1
Design ambient temperature (°C)	50	50

Rated insulation levels :

1) Full wave impulse withstand voltage (1.2/50 micro sec.)

-	between line terminals and ground for CT and CVT	± 1050 kVp	±650 kVp
-	for arrester housing	± 1050 kV peak	±650 kVp

2) One minute power frequency dry and wet withstand voltage

-	between line terminals and ground for CT and CVT	460 kV rms	275 kV rms

- for arrester housing	460 kV rms	275kV rms
Max. radio interference voltage (microvolts) for frequency between 0.5 MHz and 2 MHz in all positions of the equipment.	1000 for CT/CVT 500 for SA (at 156 kV rms)	500 (at 92 kV rms)
Minimum creepage distance :-		
Phase to ground (mm)	6125	3625
System neutral earthing	- Effectively earthed -	
Seismic acceleration	- 0.5g horizontal -	
Partial discharge for:-		
- Surge arrester at 1.05 COV	- Not exceeding 50 pc. -	
- for CT/CVT	- Not exceeding 10 pc. –	

(C) **For 33 kV, 22kV & 11kV Vacuum Circuit Breaker and Isolator**:

Rated voltage kV (rms)	36	25	
Rated frequency (Hz)	50	50	
No. of Poles	3	3	
Design ambient temperature (°C)	50	50	
Rated insulation levels :			
1) Full wave impulse withstand voltage (1.2/50 micro sec.)			
- between line terminals and ground	±170 kVp	±150 kVp	±75 kVp
- between terminals with circuit breaker open	±170 kVp	±150 kVp	±75 kVp
- between terminals with isolator open	±170 kVp	±150 kVp	±75 kVp
2) One minute power frequency dry and wet withstand voltage			
- between line terminals and ground	70kV(rms)	50kV(rms)	28kV(rms)
- between terminals with circuit breaker open	70kV(rms)	50kV(rms)	28kV(rms)
- between terminals with Isolator open	70kV(rms)	50kV(rms)	28kV(rms)
Minimum creepage distance:			
Phase to ground (mm)	900	625	300
Between CB Terminals (mm)	900	625	300
System neutral earthing	Effectively earthed		
Seismic acceleration	0.5 g	0.5 g	
Rating of Auxiliary Contacts	10 A at 250 V DC		

Breaking capacity of Auxiliary Contacts	2 A DC with circuit time constant of not less than 20ms

Auxiliary Switch shall also comply with other clauses of Chapter-GTR.

(D) FOR 33kV, 22kV & 11kV CT/VT/SA

Rated voltage kV (rms)	36	25	12
Rated frequency (Hz)	50	50	11
No. of poles	1	1	1
Design ambient temperature (°C)	50	50	50

Rated insulation levels :

1)	Full wave impulse withstand voltage (1.2/50 micro sec.)			
-	between line terminals and ground	±170 kVp	±150 kVp	±75 kVp
-	for arrester housing	±170 kVp	±150 kVp	±75 kVp
2)	One minute power frequency dry and wet withstand voltage			
-	between line terminals and ground	70kV rms	50kV rms	28kV rms
-	for arrester housing	70kV rms	50kV rms	28kV rms

Minimum creepage distance :

Phase to ground (mm)	900	625	300
Between Terminals (mm)	900	625	300
System neutral earthing	- Effectively earthed -		
Seismic acceleration	0.5 g	0.5 g	
Cantilever strength of bushing	350 kg (minimum)		

(E) Technical Parameters of Bushings/Hollow Column Insulators/support insulators for 33kV, 22kV & 11kV:

(a)	Rated Voltage (kV)	36	25	12
(b)	Impulse withstand voltage (Dry & Wet) (kVp)	±170	±150 kVp	75
(c)	Power frequency withstand voltage (dry and wet) (kV rms)	75	50	28
(d)	Total creepage distance (mm)	900	625	300

(e) Pollution Class-III Heavy (as per IEC 71) and as specified in Section-2 for all class of equipment.

5.0 ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the Purchaser shall be discussed and finalised by the Purchaser at the time of award.

The Contractor shall necessarily submit all the drawings/ documents unless anything is waived.

5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports for the approval of the Purchaser. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

5.3 Drawings

5.3.1 All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Drawings submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. Employer/Consultant has standardized few drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings alongwith type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.

5.3.3 The review of these data by the Purchaser will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. This review by the Purchaser may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Purchaser shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

5.5 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.6 All engineering data submitted by the Contractor after final process including review and approval by the Purchaser shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Purchaser in Writing.

5.7 Approval Procedure

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Purchaser would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

i)	Approval/comments/ by Purchaser on initial submission	As per agreed schedule

ii)	Resubmission (whenever required)	Within 3 (three) weeks from date of comments
iii)	Approval or comments	Within 3 (three) weeks of receipt of resubmission.
iv)	Furnishing of distribution copies (5 hard copies per substation and one scanned copy (pdf format) for Corporate Centre)	2 weeks from the date of approval
v)	Furnishing of distribution copies of test reports	
	(a) Type test reports (one scanned softcopy in pdf format per substation plus one for corporate centre & one hardcopy per substation)	2 weeks from the date of final approval
	(b) Routine Test Reports (one copy for each substation)	-do-
vi)	Furnishing of instruction/ operation manuals (2 copies per substation and one softcopy (pdf format) for corporate centre & per substation)	As per agreed schedule
(vii)	As built drawings (two sets of hardcopy per substation & one softcopy (pdf format) for corporate centre& per substation)	On completion of entire works

NOTE :

(1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Purchaser or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.

(3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.

(4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Purchaser.

(5) The Contractor shall furnish to the Purchaser catalogues of spare parts.

(6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

6.0 MATERIAL/ WORKMANSHIP

6.1 General Requirement

6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

6.1.2 Incase where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Purchaser.

6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer’s recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer’s tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer’s limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

6.1.6 The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.

6.2 Provisions for Exposure to Hot and Humid climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipments located in non-air conditioned areas shall also be of same type.

6.2.1 Space Heaters

6.2.1.1 The heaters shall be suitable for continuous operation at 230V as supply voltage. On-off switch and fuse shall be provided.

6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

6.2.2 FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.2.3 Ventilation opening

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

a) Installed out door: IP- 55

b) Installed indoor in air conditioned area: IP-31

c) Installed in covered area: IP-52

d) Installed indoor in non air conditioned area where possibility of entry of water is limited: IP-41.

e) For LT Switchgear (AC & DC distribution Boards): IP-52

The degree of protection shall be in accordance with IEC-60947 (Part-I) / IEC-60529. Type test report for degree of protection test, shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

6.3.1 Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirement.

6.3.2 All such nameplates, instruction plates, rating plates of transformers, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be provided with English inscriptions.

6.4 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into successful Operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Purchaser & contractor agree upon any such changes, the specification shall be modified accordingly.

7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

7.3 The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of

various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

7.4 The Contractor has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Purchaser. The names of agencies shall be intimated to the successful bidders.

7.5 The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his

own cost at Owner's Corporate Centre, Nepal or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's Works or at his Sub-contractor's premises or at the Purchaser's site or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be broadly outlined by the contractor and finalised after discussions before the award of contract. The detailed programme shall be submitted by the contractor after the award for reference. A quality assurance programme of the contractor shall generally cover the following:

(a) His organisation structure for the management and implementation of the proposed quality assurance programme:

(b) Documentation control system;

(c) Qualification data for bidder's key personnel;

(d) The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

(e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;

(f) Control of non-conforming items and system for corrective actions;

(g) Inspection and test procedure both for manufacture and field activities.

(h) Control of calibration and testing of measuring instruments and field activities;

(i) System for indication and appraisal of inspection status;

(j) System for quality audits;

(k) System for authorising release of manufactured product to the Purcahser.

(l) System for maintenance of records;

(m) System for handling storage and delivery; and

(n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Purchaser or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The contractor would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of purchaser's inspection of equipment/material

9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective chapters.

9.2 The reports for all type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by Utility or representative of accredited test lab or reputed consultant.

The test reports submitted shall be of the tests conducted within last 10 (ten) years prior to the originally Scheduled date of bid opening. In case the test reports are of the test conducted earlier than 10 (ten) years prior to the originally Scheduled date of bid opening, the contractor shall repeat these test(s) at no extra cost to the purchaser.

However, in case of instrument transformers, the following type tests should have been conducted within 5 (five) years prior to the originally Scheduled date of bid opening.

i) Lightning Impulse Test

ii) Switching Impulse Test

iii) Multiple Chopped Impulse Test (For CT)

iv) Chopped Impulse Test (For CVT)

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the originally Scheduled date of bid opening, the contractor shall repeat these test(s) at no extra cost to the purchaser.

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

The Contractor shall intimate the Purchaser the detailed program about the tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

Further, in case type tests are required to be conducted/repeated and the deputation of Inspector/Purchaser's representative is required, then all the expenses shall be borne by the contractor.

9.3 The Purchaser, his duly authorized representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractor’s/sub-vendors premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Contractor’s own premises or works. Inspection may be made at any stage of manufacture,

dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

9.4 The Contractor shall give the Purchaser /Inspector fifteen (15) days written notice for on-shore and six (6) weeks notice for off-shore material being ready for joint testing including contractor and Purchaser. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Purchaser /inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.5 The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Purchaser /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

9.6 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Purchaser/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser /Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/Inspector. Failure of the Purchaser /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Purchaser.

9.7 In all cases where the Contract provides for tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorized representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser /Inspector or to his authorized representative to accomplish testing.

9.8 The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

9.9 The Purchaser will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

9.10 The Purchaser reserves the right for getting any field tests not specified in respective chapters of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Purchaser.

10.0 TESTS

10.1 Pre-commissioning Tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Purchaser and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Purchaser will calibrate, all such measuring equipment and devices as far as practicable.

10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed on production of requisite documents.

11.0 PACKAGING & PROTECTION

11.1 All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Purchaser, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.

11.2 All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 FINISHING OF METAL SURFACES

12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to Equivalent International Standards.

12.2 HOT DIP GALVANISING

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq. m minimum.

12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

12.2.3 After galvanizing. no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

12.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IEC.

12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005/Equivalent International standard “Code of practice for phosphating iron and sheet”. All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

12.3.2 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved.

12.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective chapters of the equipments. Glossy white colour inside the equipments /boards /panels/junction boxes is also acceptable. The exterior colour for panels shall be matching with the existing panels in case of extension of a substation. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

12.3.5 In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted alongwith the Bids for Purchaser's review & approval.

12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

S.No.	PIPE LINE	Base colour	Band colour
Fire Protection System			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line – water	FIRE RED	Sea Green
3	Emulsifier system detection line – Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
Air Conditioning System			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

The direction of flow shall be marked by → (arrow) in black colour.

Base Colour Direction of flow Band Colour

12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting.

13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a

neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

13.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

13.3 The contractor shall have to ensure that the hard and flat indoor and outdoor storage areas are in place prior to commencement of delivery of material at site. Contractor shall also ensure availability of proper unloading and material handling equipment like cranes etc. and polyester/nylon ropes of suitable capacity to avoid damage during unloading and handling of material at site. All indoor equipments shall be stored indoors. Outdoor equipment may be stored outdoors but on a hard and flat raised area properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress. However, all associated control panels, marshalling boxes operating boxes etc. of outdoor equipments are to be stored indoors only.

Storage of equipment on top of another one is not permitted if the wooden packing is used. Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations.

During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.

13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

13.6 Contractor shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. The Contractor shall submit to the Purchaser every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

13.7 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.

13.8 Where material / equipment is unloaded by Purchaser before the Contractor arrives at site or even when he is at site, Purchaser by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.

13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

13.10 The words 'erection' and 'installation' used in the specification are synonymous.

13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

13.12 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances as given in clause 4.7.1 the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

13.13 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

14.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

15.0 AUXILIARY SUPPLY

15.1 The sub-station auxiliary supply is normally met through a system indicated under chapter "Electrical & Mechanical Auxiliaries" having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following.

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/Wire	Neutral connection
400V	± 10	50 ± 2.5%	3/4 Wire	Solidly Earthed.
230V	± 10	50 ± 2.5%	1/2 Wire	Solidly Earthed.
220V	190V to 240V	DC	-	Isolated 2 wire System
110V	95V to 120V	DC	-	Isolated 2 wire System
48V	_	DC	_	2 wire system (+) earthed

Combined variation of voltage and frequency shall be limited to ± 10%.

16.0 SUPPORT STRUCTURE

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 5.9 meter from plinth level for 245 kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

16.2 Support structure shall meet the following mandatory requirements:

16.2.1 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

17.1 All power clamps and connectors shall conform to ANSI/NEMA CC1/ Equivalent International standard and shall be made of materials listed below :

For connecting ,ACSR conductors	Aluminum alloy casting conforming to BS:1490/ Equivalent International Standard
For connecting equipment terminals made of copper with ACSR conductors	Bimetallic connectors made from aluminum alloy casting conforming to BS:1490/ Equivalent International Standard with 2mm thick bimetallic liner.
For connecting GI	Galvanized mild shield wire
i) Bolts nuts and plain washers	Electrogalvanised for sizes Plain, washers below M12, for thers hot dip galvanised.
ii) Spring washers for item ‘a’ to ‘c’	Electrogalvanised mild steel

17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

17.3 Where copper to aluminum connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress.

17.4 Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of Work.

17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2 mm thickness

shall be cast integral with aluminum body or 2 mm thick bi-metallic strips shall be provided for Bi-metallic clamps.

17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of 4" IPS AL. tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

17.8 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

17.10 Clamps and connectors shall be designed to be corona controlled.

17.11 Tests

17.11.1 Clamps and connectors should be type tested as per NEMA CC1/ Equivalent International Standard and shall also be subjected to routine tests as per NEMA CC1/ Equivalent International Standard. Following type test reports shall be submitted for approval as per clause 9.2 above except for sl. no.(ii) & (iii) for which type test once conducted shall be applicable (i.e. the requirement of test conducted within last ten years shall not be applicable).

i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)

ii) Short time current test

iii) Corona (dry) and RIV (dry) test (for 220 KV and above voltage level clamps)

iv) Resistance test and tensile test

18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IEC-60439, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

18.3 A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rain water.

18.4 Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure

uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.

18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene gaskets. The gasket shall be tested in accordance with approved quality plan, BS:4255 / Equivalent International Standard . Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

18.7 A 230V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.

18.8 For illumination, a fluorescent tube or CFL of approximately 9 to 15 watts shall be provided. The switching of the fittings shall be controlled by the door switch. .

For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.

18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.

18.10 Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.

18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.

18.12 a) The following routine tests alongwith the routine tests as per IEC 60529/ Equivalent International Standard shall also be conducted:

i) Check for wiring

ii) Visual and dimension check

b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 as per IEC 60529/ Equivalent International Standard including application of, 2.0 KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.

20.0 TERMINAL BLOCKS AND WIRING

20.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and

external connections to equipment or to control cubicles will be made through terminal blocks.

20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non breakable type. These shall be of moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type of Elmex or Phoenix or Wago or equivalent make.

20.3 Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

20.4 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

20.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.

20.6 The terminal blocks shall be of extensible design.

20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

20.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

a)	All circuits except CT/PT circuits	Minimum of two of 2.5 sq mm copper flexible.
b)	All CT/PT circuits	Minimum of 4 nos. of 2.5 sq mm copper flexible.

20.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

20.11 Atleast 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

20.13 The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets.

20.14 All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

21.0 LAMPS & SOCKETS

21.1 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round plug as per Nepalese Standard. They shall be switched sockets with shutters.

21.2 Hand Lamp:

A 230 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

21.3 Switches and Fuses:

21.3.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breaker / switchfuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

21.3.2 All fuses shall be of HRC cartridge type conforming to IS:9228/ Equivalent International Standard mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

22.0 Bushings, Hollow Column Insulators, Support Insulators:

22.1 Bushings shall be manufactured and tested in accordance with IEC-60137 while hollow column insulators shall be manufactured and tested in accordance with IEC-62155.The support insulators shall be manufactured and tested as per IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable.

The bidder may also offer composite hollow insulators, conforming to IEC-61462.

22.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

22.4 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

22.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by

chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

22.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

22.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

22.8 Tests

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099 & IS: 2544 & IS : 5621/ Equivalent International Standard .

23.0 MOTORS

Motors shall be “Squirrel Cage” three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

23.1 Enclosures

a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP-55 as per IEC 60529/ Equivalent International Standard . For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP-44 as per IS: 4691/ Equivalent International Standard .

b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.

c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.

d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

23.2 Operational Features

a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.

b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Chapter.

23.3 Starting Requirements:

a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding

temperature even when the supply voltage drops down to 80% of the rated voltage.

b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS:325/ Equivalent International Standard .

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding atleast two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

23.4 Running Requirements:

a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS:325/ Equivalent International Standard (for 3 - phase induction motors) after adjustment due to increased ambient temperature specified.

b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729/ Equivalent International Standard. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

23.5 TESTING AND COMMISSIONING

An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

(a) Insulation resistance.

(b) Phase sequence and proper direction of rotation.

(c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

24.0 TECHNICAL REQUIREMENT OF EQUIPMENTS

24.1 1.1 KV Grade Power & Control Cables

24.1.1 Applicable for PVC Control Cable

The manufacturers, whose PVC control cables are offered, should have designed, manufactured, tested and supplied in a single contract at least 100 Kms of 1.1 KV grade PVC insulated control cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 27C x 2.5 Sq.mm or higher size as on the originally Scheduled date of bid opening.

24.1.2 Applicable for PVC Power Cable

The manufacturer, whose PVC Power Cables are offered, should have designed, manufactured, tested and supplied in a single contract atleast 100 Kms of 1.1 KV or higher grade PVC insulated power cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 150 Sq. mm or higher size as on the originally Scheduled date of bid opening.

24.1.3 Applicable for XLPE Power Cables

The Manufacturer, whose XLPE Power cables are offered, should have designed, manufactured, tested and supplied in a single contract atleast 25 Kms of 1.1 KV or higher grade XLPE insulated power cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 630 Sq. mm or higher size as on the originally Scheduled date of bid opening.

24.2 LT Switchgear

24.2.1 The Manufacturer whose LT Switchgear are offered, should be a manufacturer of LT Switchboards of the type and rating being offered. He should have designed, manufactured, tested and supplied at least 50 nos. draw out circuit breaker panels, out of which at least 5 nos. should have been with relay and protection schemes with current transformer. He should have also manufactured at least 50 nos MCC panels comprising of MCCBs (ie Moulded Case Circuit Breakers) modules of the type offered which should be in successful operation as on originally Scheduled date of bid opening.

24.2.2 The Switchgear items (such as circuit breakers, fuse switch units, contactors etc.), may be of his own make or shall be procured from reputed manufacturers and of proven design. At least one hundred circuit breakers of the make and type being offered shall be operating satisfactory as on originally Scheduled date of bid opening.

ANNEXURE - A

LIST OF SPECIFICATIONS

GENERAL STANDARDS AND CODES

IEC-60060 (Part 1 to P4)	-	High Voltage Test Techniques
IEC 60068	-	Environmental Test
IEC-60117	-	Graphical Symbols
IEC-60156,	-	Method for the Determination of the Electrical Strength of Insulation Oils.
IEC-60270,	-	Partial Discharge Measurements.
IEC-60376	-	Specification and Acceptance of New Sulphur Hexafloride
IEC-60437	-	Radio Interference Test on High Voltage Insulators.
IEC-60507	-	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems.
IEC-62271-1	-	Common Specification for High Voltage Switchgear & Controlgear Standards.
IEC-60815	-	Guide for the Selection of Insulators in respect of Polluted Conditions.
IEC-60865 (P1 & P2)	-	Short Circuit Current - Calculation of effects.
ANSI-C.1/NFPA.70	-	National Electrical Code
ANSI-C37.90A	-	Guide for Surge Withstand Capability (SWC) Tests
ANSI-C63.21,	-	Specification for Electromagnetic Noise and
C63.3	-	Field Strength Instrumentation 10 KHz to 1 GHZ
C36.4ANSI-C68.1	-	Techniquest for Dielectric Tests
ANSI-C76.1/EEE21	-	Standard General Requirements and Test Procedure for Outdoor Apparatus Bushings.
ANSI-SI-4	-	Specification for Sound Level Metres
ANSI-Y32-2/C337.2	-	Drawing Symbols
ANSI-Z55.11	-	Gray Finishes for Industrial Apparatus and Equipment No. 61 Light Gray
NEMA-107T	-	Methods of Measurements of RIV of High Voltage Apparatus
NEMA-ICS-II	-	General Standards for Industrial Control and Systems Part ICSI-109
CISPR-1	-	Specification for CISPR Radio Interference Measuring Apparatus for the frequency range 0.15 MHz to 30 MHz
CSA-Z299.1-1978h	-	Quality Assurance Program Requirements
CSA-Z299.2-1979h	-	Quality Control Program Requirements

CSA-Z299.3-1979h	-	Quality Verification Program Requirements
CSA-Z299.4-1979h	-	Inspection Program Requirements

TRANSFORMERS AND REACTORS

IEC-60076 (Part 1 to 5)	-	Power Transformers
IEC-60214	-	On-Load Tap-Changers.
IEC-60289	-	Reactors.
IEC- 60354	-	Loading Guide for Oil - Immersed power trans formers
IEC-60076-10	-	Determination of Transformer and Reactor Sound Levels
ANSI-C571280	-	General requirements for Distribution, Power and Regulating Transformers
ANSI-C571290	-	Test Code for Distribution, Power and Regulation Transformers
ANSI-C5716	-	Terminology & Test Code for Current Limiting Reactors
ANSI-C5721	-	Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 KVA
ANSI-C5792	-	Guide for Loading Oil-Immersed Power Transformers upto and including 100 MVA with 55 deg C or 65 deg C Winding Rise
ANSI-CG,1EEE-4	-	Standard Techniques for High Voltage Testing

CIRCUIT BREAKERS

IEC-62271-100	-	High-voltage switchgear and controlgear - Part 100: Alternating current circuit-breakers
IEC-62271-101	-	High-voltage switchgear and controlgear - Part 101: Synthetic testing
IEC-62155	-	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC-62271-110	-	High-voltage switchgear and controlgear - Part 110: Inductive load switching
IEC-62271-109	-	High-voltage switchgear and controlgear - Part 110: Inductive load switching

CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS

IEC-60044-1	-	Current transformers.
IEC-60044-2	-	Inductive Voltage Transformers.
IEC-60044-5	-	Instrument transformers - Part 5: Capacitor voltage transformers
IEC-60358	-	Coupling capacitors and capacitor dividers.

IEC-60044-4	-	Instrument Transformes : Measurement of Partial Discharges
IEC-60481	-	Coupling Devices for power Line Carrier Systems.
ANSI-C5713	-	Requirements for Instrument transformers
ANSIC92.2	-	Power Line Coupling voltage Transformers
ANSI-C93.1	-	Requirements for Power Line Carrier Coupling Capacitors
BUSHING		
IEC-60137	-	Insulated Bushings for Alternating Voltages above 1000V
SURGE ARRESTERS		
IEC-60099-4	-	Metal oxide surge arrestors without gaps
IEC-60099-5	-	Selection and application recommendation
ANSI-C62.1	-	IEE Standards for S A for AC Power Circuits
NEMA-LA 1	-	Surge Arresters
CUBICLES AND PANELS & OTHER RELATED EQUIPMENTS		
IEC-60068.2.2	-	Basic environmental testing procedures Part 2: Test B: Dry heat
IEC-60529	-	Degree of Protection provided by enclosures.
IEC-60947-4-1	-	Low voltage switchgear and control gear.
IEC-61095	-	Electromechanical Contactors for household and similar purposes.
IEC-60439 (P1 & 2)	-	Low Voltage Switchgear and control gear assemblies
ANSI-C37.20	-	Switchgear Assemblies, including metal enclosed bus.
ANSI-C37.50	-	Test Procedures for Low Voltage Alternating Current Power Circuit Breakers
ANSI-C39	-	Electric Measuring instrument
ANSI-C83	-	Components for Electric Equipment
NEMA-AB	-	Moulded Case Circuit and Systems
NEMA-CS	-	Industrial Controls and Systems
NEMA-PB-1	-	Panel Boards
NEMA-SG-5	-	Low voltage Power Circuit breakers
NEMA-SG-3	-	Power Switchgear Assemblies
NEMA-SG-6	-	Power switching Equipment
NEMA-5E-3	-	Motor Control Centers
1248 (P1 to P9)	-	Direct acting indicating analogue electrical measuring instruments & their accessories.
Disconnecting switches		
IEC-62271-102	-	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches

IEC-60265 (Part 1 & 2)	-	High Voltage switches
ANSI-C37.32	-	Schedule of preferred Ratings, Manufacturing Specifications and Application Guide for high voltage Air Switches, Bus supports and switch accessories
ANSI-C37.34	-	Test Code for high voltage air switches
NEMA-SG6	-	Power switching equipment
PLCC and line traps		
IEC-60353	-	Line traps for A.C. power systems.
IEC-60481	-	Coupling Devices for power line carrier systems.
IEC-60495	-	Single sideboard power line carrier terminals
IEC-60683	-	Planning of (single Side-Band) power line carrier systems.
CIGRE	-	Teleprotection report by Committee 34 & 35.
CIGRE	-	Guide on power line carrier 1979.
CCIR	-	International Radio Consultative Committee
CCITT	-	International Telegraph & Telephone Consultative Committee
EIA	-	Electric Industries Association
Protection and control equipment		
IEC-60051: (P1 to P9)	-	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories.
IEC-60255 (Part 1 to 23)	-	Electrical relays.
IEC-60297		
(P1 to P4)	-	Dimensions of mechanical structures of the 482.6mm (19 inches) series.
IEC-60359	-	Expression of the performance of electrical & electronic measuring equipment.
IEC-60387	-	Symbols for Alternating-Current Electricity meters.
IEC-60447	-	Man machine interface (MMI) - Actuating principles.
IEC-60521	-	Class 0.5, 1 and 2 alternating current watt hour metres
IEC-60547	-	Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
ANSI-81	-	Screw threads
ANSI-B18	-	Bolts and Nuts
ANSI-C37.1	-	Relays, Station Controls etc.
ANSI-C37.2	-	Manual and automatic station control, supervisory and associated telemetering equipment
ANSI-C37.2	-	Relays and relay systems associated with electric power apparatus

ANSI-C39.1	-	Requirements for electrical analog indicating instruments
MOTORS		
IEC-60034 (P1 to P19:)	-	Rotating electrical machines
IEC-Document 2	-	Three phase induction motors
(Central Office) NEMA-MGI		Motors and Generators
Electronic equipment and components		
MIL-21B, MIL-833 & MIL-2750		
IEC-60068 (P1 to P5)	-	Environmental testing
IEC-60326 (P1 to P2)	-	Printed boards
		Material and workmanship standards
ASTM	-	Specification and tests for materials
Clamps & connectors		
NEMA-CC1	-	Electric Power connectors for sub station
NEMA-CC 3	-	Connectors for Use between aluminium or aluminum-Copper Overhead Conductors
Bus hardware and insulators		
IEC-60120	-	Dimensions of Ball and Socket Couplings of string insulator units.
IEC-60137	-	Insulated bushings for alternating voltages above 1000 V.
IEC-60168	-	Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V.
IEC-62155	-	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC-60273	-	Characteristices of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC-61462	-	Pressurized and un-pressurized insulator for use in electrical equipment with rated voltage greater than 1000V – Definitions, Test methods, acceptance criteria and design recommendations
IEC-60305	-	Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for a.c. systems Characteristics of String Insulator Units of the cap and pintype.
IEC-60372 (1984)	-	Locking devices for ball and socket couplings of string insulator units : dimensions and tests.
IEC-60383 (P1 and P2)	-	Insulators for overhead lines with a nominal voltage above 1000 V.
IEC-60433	-	Characteristics of string insulator units of the long rod type.

IEC-60471	-	Dimensions of Clevis and tongue couplings of string insulator units.
ANSI-C29	-	Wet process proelain insulators
ANSI-C29.1	-	Test methods for electrical power insulators
ANSI-C92.2	-	For insulators, wet-process porcelain and toughened glass suspension type
ANSI-C29.8	-	For wet-process porcelain insulators apparatus, post-type
ANSI-G.8	-	Iron and steel hardware
CISPR-7B	-	Recommendations of the CISPR, tolerances of form and of Position, Part 1
ASTM A-153	-	Zinc Coating (Hot-Dip) on iron and steel hardware
Strain and rigid bus-conductor		
ASTM-B 230-82	-	Aluminum 1350 H19 Wire for electrical purposes
ASTM-B 231-81	-	Concentric - lay - stranded, aluminum 1350 conductors
ASTM-B 221	-	Aluminum - Alloy extruded bar, road, wire, shape
ASTM-B 236-83	-	Aluminum bars for electrical purpose (Bus-bars)
ASTM-B 317-83	-	Aluminum-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes (Bus Conductors)
Batteries and batteries charger		
Battery		
IEC:60896-21&22	-	Lead Acid Batteries Valve Regulated types – Methods of Tests & Requirements
IEC: 60623	-	Vented type nickel Cadmium Batteries
IEC:60622	-	Secondary Cells & Batteries – Sealed Ni-Cd rechargeable single cell
IEC:60623	-	Secondary Cells & Batteries – Vented Ni-Cd rechargeable single cell
IEC:60896-11	-	Stationary Lead Acid Batteries – Vented Type – General requirements & method of tests
IEEE-485	-	Recommended practices for sizing of Lead Acid Batteries
IEEE-1115	-	Sizing of Ni-Cd Batteries
IEEE-1187	-	Recommended practices for design & installation of VRLA Batteries
IEEE-1188	-	Recommended practices for design & installation of VRLA Batteries
IEEE-1189	-	Guide for selection of VRLA Batteries
Battery Charger		
IEEE-484	-	Recommended Design for installation design and installation of large lead storage batteries for generating stations and substations.

IEEE-485	-	Sizing large lead storage batteries for generating stations and substations
Wires and cables		
ASTMD-2863	-	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
IEC-60096 (part 0 to p4)	-	Radio Frequency cables.
IEC-60183	-	Guide to the Selection of High Voltage Cables.
IEC-60189 (P1 to P7)	-	Low frequency cables and wires with PVC insulation and PVC sheath.
IEC-60227 (P1 to P7)	-	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V.
IEC-60228	-	Conductors of insulated cables
IEC-60230	-	Impulse tests on cables and their accessories.
IEC-60287 (P1 to P3)	-	Calculation of the continuous current rating of cables (100% load factor).
IEC-60304	-	Standard colours for insulation for low-frequency cables and wires.
IEC-60331	-	Fire resisting characteristics of Electric cables.
IEC-60332 (P1 to P3)	-	Tests on electric cables under fire conditions.
IEC-60502	-	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto to 30 kV
IEC-754 (P1 and P2)	-	Tests on gases evolved during combustion of electric cables.
Painting		
ANSI-Z551	-	Gray finishes for industrial apparatus and equipment
SSPEC	-	Steel structure painting council
HORIZONTAL CENTRIFUGAL PUMPS		
API-610	-	Centrifugal pumps for general services
	-	Hydraulic Institutes Standards
BS:599	-	Methods of testing pumps
PTC-8.2	-	Power Test Codes - Centrifugal pumps
DIESEL ENGINES		
ASME Power Test Code	-	Internal combustion engine PTC-17
	-	Codes of Diesel Engine Manufacturer's Association, USA
PIPING VALVES & SPECIALITIES		
BS:5150	-	Specification for cast iron gate valves
PG Test Procedures		
NFPA-13	-	Standard for the installation of sprinkler system

NFPA-15	-	Standard for water spray fixed system for the fire protection
NFPA-12A	-	Standard for Halong 1301 Fire Extinguishing System
NFPA-72E	-	Standard on Antomatic Fire Detectors
NFPA-12	-	Standard on Carbon dioxide extinguisher systems

Electrical generating and distributing stations code of practice

Steel structures

ANSI-B18.2.1	-	Inch series square and Hexagonal bolts and screws
ANSI-B18.2.2	-	Square and hexagonal nuts
ANSI-G8.14	-	Round head bolts
ASTM-A6	-	Specification for General Requirements for rolled steel plates, shapes, sheet piling and bars of structural use
ASTM-A36	-	Specifications of structural steel
ASTM-A47	-	Specification for malleable iron castings
ASTM-A143	-	Practice for safeguarding against embilement of Hot Galvanized structural steel products and procedure for detaching embrilement
ASTM-A242	-	Specification for high strength low alloy structural steel
ASTM-A283	-	Specification for low and intermediate tensile strength carbon steel plates of structural quality
ASTM-A394	-	Specification for Galvanized steel transmission tower bolts and nuts
ASTM-441	-	Specification for High strength low alloy structural manganese vanadium steel.
ASTM-A572	-	Specification for High strength low alloy colombium-Vanadium steel of structural quality
AWS D1-0	-	Code for welding in building construction welding inspection
AWS D1-1	-	Structural welding code
AISC	-	American institute of steel construction
NEMA-CG1	-	Manufactured graphite electrodes

Piping and pressure vessels

ASME	-	Boiler and pressure vessel code
ASTM-A120	-	Specification for pipe steel, black and hot dipped, zinc-coated (Galvanized) welded and seamless steel pipe for ordinary use
ASTM-A53	-	Specification for pipe, steel, black, and hot-dipped, zinc coated welded and seamless
ASTM-A106	-	Seamless carbon steel pipe for high temperature service
ASTM-A284	-	Low and intermediate tensile strength carbon-silicon steel plates for machine parts and general construction.

ASTM-A234	-	Pipe fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ASTM-S181	-	Specification for forgings, carbon steel for general purpose piping
ASTM-A105	-	Forgings, carbon steel for piping components
ASTM-A307	-	Carbon steel externally threated standard fasteners
ASTM-A193	-	Alloy steel and stainless steel bolting materials for high temperature service
ASTM-A345	-	Flat rolled electrical steel for magnetic applications
ASTM-A197	-	Cupola malleable iron
ANSI-B2.1	-	Pipe threads (Except dry seal)
ANSI-B16.1	-	Cast iron pipe flangesand glanged fitting. Class 25, 125, 250 and 800
ANSI-B16.1	-	Malleable iron threaded fittings, class 150 and 300
ANSI-B16.5	-	Pipe flanges and flanged fittings, steel nickel alloy and other special alloys
ANSI-B16.9	-	Factory-made wrought steel butt welding fittings
ANSI-B16.11	-	Forged steel fittings, socket-welding and threaded
ANSI-B16.14	-	Ferrous pipe plug, bushings and locknuts with piplethreads
ANSI-B16.25	-	Butt welding ends
ANSI-B18.1.1	-	Fire hose couplings screw thread.
ANSI-B18.2.1	-	Inch series square and hexagonal bolts and screws
ANSI-B18.2.2	-	Square and hexagonal nuts
NSI-B18.21.1	-	Lock washers
ANSI-B18.21.2	-	Plain washers
ANSI-B31.1	-	Power piping
ANSI-B36.10	-	Welded and seamless wrought steel pipe
ANSI-B36.9	-	Stainless steel pipe

ACSR MOOSE CONDUCTOR

IEC:437-1973	Test on High Voltage Insulators NEMA:107-1964 CISPR
Part - V	Overhead Transmission Purposes
BS:215(Part-II)	Aluminium Conductors galvanized IEC:209-1966 steel reinforced extra high
BS:215(Part-II)	voltage (400 kV and above)

GALVANISED STEEL EARTHWIRE

P5:1992)	overhead transmission purposes.

ANNEXURE - B

Sl No.	LIST OF DRAWINGS/DOCUMENTS
1	Single Line Diagram
2	Electrical Layout – Plan and Sections
3	Tower, Equipment & cable trench layout drawing
4	Earthing system design calculation & layout drawing
5	Lighting protection system design & drawings
6	Structure Layout (Plan & Section) drawing
7	Cantilever Strength calculations (if applicable)
8	Design calculation for Sag – Tension stringing chart
9	GTP and drawings for Bus-Post Insulator
10	Tension/suspension string insulator and Hardware Assembly GTP and drawing
11	Soil Investigation Report (if applicable)
12	**Circuit Breakers (220kV,132kV, 66kv, 33 kV- As applicable)** - GA drawing, GTP, Type test Reports
13	**CTs & CVTs (220kV,132 kV, 66kv,33kV- As applicable)** - GA drawing, GTP, Type test Reports
14	**Surge Arrestors (216kV,120kV, 60kv, 30kV- As applicable)** - GA drawing, GTP, Type test Reports
15	**Isolators (220kV,132kV, 66kv,33 kV- As applicable)** - GA drawing, GTP, Type test Reports
16	**Control, Relay Panels and Substation Automation system** - GTP, technical literature, type test reports
17	**PLCC, LINE TRAP & Digital Protection Coupler** - GTP and technical literature
18	**Civil Works (as applicable)** **a)** Control Room Building Structure Design, Foundation Design & Drg., Plinth Beam Design & Drg. and column Design & Drg. upto G.F. Level **b)** Auto transformer foundation design/drawings **c)** Reactor foundation design/drawings **d)** 220/132/66/11kV Tower,Transformer, structure & foundation design/drawings. **e)** 220/132/66/11kV Equipment support structure & foundation design/drawing

NOTE:

1. The above list of drawing/document is only illustrative and not exhaustive. The contractor shall submit drawings/documents as per requirement of Technical specification.

CHAPTER 3: SWITCHGEAR
INSTRUMENT TRANSFORMERS
CONTENTS

CHAPTER 3 - SWITCHGEAR

INSTRUMENT TRANSFORMERS

1.0 GENERAL:

1.1 The instrument transformers and accessories shall conform to the latest version of the standards specified below except to the extent explicitly modified in the specification and shall be in accordance with the requirements in Chapter 2-GTR.

Current Transformers IEC: 60044-1

Capacitive Voltage Transformers IEC:60044-5 / IEC-60358

Inductive Voltage Transformers IEC:60044-2

1.2 The instrument transformers shall be complete with its terminal box and a common marshalling box for a set of 3 instrument transformers.

1.3 The external surface of instrument transformer, if made of steel, shall be hot dip galvanized or painted as per **Chapter 2-GTR.**External surface of alumunium can have natural finish.

1.4 The impregnation details along with tests/checks to ensure successful completion of impregnation cycle shall be furnished for approval.

1.5 The instrument transformers shall be designed for use in geographic and meteorological conditions as given in Chapter 2-GTR.

2.0 CONSTRUCTION FEATURES:

The features and constructional details of instrument transformers shall be in accordance with requirements stipulated hereunder:

2.1 a) Instrument transformers shall be of 245/145 kV class, oil filled/ SF6 gas filled, suitable for outdoor service and upright mounting on steel structures. 245/145 kV Instrument transformers shall be with shedded porcelain/ polymer bushings/Insulators

b) Bushings/Insulators shall conform to requirements stipulated in Section-GTR. The bushing/insulator for CT shall be one piece without any metallic flange joint.

c) Oil filling and drain plugs, oil sight glass shall be provided for CT and for electromagnetic unit of CVT etc. The Instrument transformer shall have cantilever strength of not less than 350 kg and 350 kg **respectively for** 245kV and 145 kV Instrument transformers. For CVT with polymer housing, the cantilever strength shall not be less than 150kg. Oil filling and drain plugs are not required with SF6 gas filled CT.

d) Instruments transformers shall be hermetically sealed units. Bidder/ Manufacturer shall furnish details of the arrangements made for the sealing of instrument transformers *during detailed engineering*.

Bidder/Manufacturer shall also furnish the details of site tests to check the effectiveness of hermetic sealing for approval.

e) Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.

f) In case of SF_6 filled CTs/Inductive VTs, it shall be provided with a suitable SF_6 gas density monitoring device, with NO/NC contacts to facilitate the remote annunciation and tripping in case of SF_6 leakage. Provisions shall be made for online gas filling. Suitable rupture disc shall be provided to prevent explosion.

2.2 **Terminal box/Marshalling Box:**

Terminal box shall conform to the requirements of Chapter 2-GTR.

2.3 **Insulating Oil:**

a) Insulating oil to be used for instrument transformers shall be of EHV grade and shall conform to IEC - 60296 (required for first filling). Non–PCB based synthetic insulating oil conforming to IEC 60867 can also be used in the capacitor units of CVT with specific approval from the owner, the proposal for which shall be submitted during detailed engineering stage.

b) The SF6 gas shall comply with IEC-60376, 60376A and 60376B and shall be suitable in all respects for use in the switchgear under operating conditions.

2.4 **Name Plate:**

Name plate shall conform to the requirements of IEC incorporating the year of manufacture. The rated current, extended current rating in case of current transformers and rated voltage, voltage factor in case of voltage transformers shall be clearly indicated on the name plate. The rated thermal current in case of CT shall also be marked on the name plate.

The intermediate voltage in case of capacitor voltage transformer shall be indicated on the name plate.

3.0 CURRENT TRANSFORMERS:

a) Current transformers shall have single primary either ring type, or hair pin type and suitably designed for bringing out the secondary terminals in a weather proof (IP 55) terminal box at the bottom. PF Terminal for measurement of tan delta and capacitance of the unit shall be provided. These secondary terminals shall be terminated to stud type non disconnecting terminal blocks inside the terminal box. In case "Bar primary" inverted type current transformers are offered the manufacturer will meet following additional requirements:

(i) The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.

(ii) The lowest part of the insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.c

(iii) The upper part of insulation assembly resting on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly & top dome.

(iv) Nitrogen if used for hermetic sealing (in case of live tank design) should not come in direct contact with oil.

(v) Bidder/Manufacturer shall recommend whether any special storage facility is required for spare CT.

b) Different ratios specified shall be achieved by secondary taps only and primary reconnection shall not be accepted.

c) Core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios with specified CT parameters.

d) The expansion chamber at the top of the porcelain insulators should be suitable for expansion of oil.

e) Facilities shall be provided at terminal blocks in the marshalling box for star delta formation, short circuiting and grounding of CT secondary terminals.

f) Current transformer's guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

g) For 245/145 kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs as specified in the Chapter 1 – GTS.

h) For 245/145 kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 5% to 120%(or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.

i) The current transformer shall be suitable for horizontal transportation. It shall be ensured that the CT is able to withstand all the stresses imposed on it while transporting and there shall be no damage in transit. The Contractor shall submit the details of packing design to the Purchaser for review.

j) For 245/145 kV CTs the instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably be inbuilt construction of the CTs. In case these are to be mounted separately these shall be mounted in the central marshalling box suitably wired upto the terminal blocks.

k) The wiring diagram plate for the interconnections of the three single phase CTs shall be provided inside the marshalling box. A typical wiring diagram No. 0000-000-T-E-L-028 (Sh. 1 & 2) is enclosed herewith to be followed by the Bidder/Manufacturer

l) The current transformers should be suitable for mounting on lattice support structure or pipe structure to be provided by the Contractor in accordance with stipulations of Chapter 2-GTR.

m) The CT shall be so designed as to achieve the minimum risks of explosion in service. Bidder/Manufacturer shall bring out in his offer, the measures taken to achieve this.

n) 245/145 kV current transformers shall be suitable for high speed auto reclosing.

4.0 VOLTAGE TRANSFORMERS:

a) 245/145 kV Voltage transformers shall be capacitor voltage divider type with electromagnetic units and shall be suitable for carrier coupling..

b) Voltage transformers secondaries shall be protected by HRC cartridge type fuses or MCBs for all the windings. In addition fuses/MCBs shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the VTs shall be terminated to the stud type non - disconnecting terminal blocks in the individual phase secondary boxes via the fuse/MCB.

c) CVTs shall be suitable for high frequency (HF) coupling required for power line carrier communication. Carrier signal must be prevented from flowing into potential transformer (EMU) circuit by means of a RF choke/reactor suitable for effectively blocking the carrier signals over the entire carrier frequency range i.e. 40 to 500 KHz. Details of the arrangement shall be furnished along with the bid. H.F. terminal of the VT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling filters of the carrier communication equipment, when utilised. Further, earthing link with fastener to be provided for HF terminal.

d) The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have separate terminal box with all the secondary terminals brought out.

e) The damping device, which should be permanently connected to one of the secondary windings, should be capable of suppressing the ferroresonance oscillations.

f) The accuracy of 0.2 on secondary III for all VTs should be maintained through out the entire burden range upto 50 VA on all the windings without any ad-justments during operation.

g) 245/145 kV CVTs shall be suitable for mounting on tubular GI pipe in accordance with stipulations of Chapter 2-GTR.

h) It should be ensured that access to secondary terminals is without any danger of access to high voltage circuit.

i) A protective surge arrester shall be provided *if required,* to prevent breakdown of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, tuning reactor/RF choke etc. due to short circuit

in transformer secondaries. In case of an alternate arrangement, bidder shall bring out the details in the bid.

j) The wiring diagram for the interconnection of the three single phase CVTs shall be provided inside the marshalling box in such a manner that it does not deteriorate with time. *A typical wiring diagram no. : 0000-000-T-E-L-029 is enclosed herewith to be followed by the Bidder/Manufacturer.*

5.0 TERMINAL CONNECTORS:

The terminal connectors shall meet the requirements as given in Chapter 2-GTR.

6.0 TESTS:

6.1 In accordance with the requirements in Section-GTR, Current and Voltage Transformers should have been type tested and shall be subjected to routine tests in accordance with IEC:60044-1 and IEC: 60044-5/60044-2 respectively.

6.2 The test reports of the type tests and the following additional type tests (additional type tests are required for Instrument Transformers, rated above 72.5 kV only) shall also be submitted for the Purchaser's review.

a) **Current Transformers:**

i) Radio interference voltage test as per IEC 60044-1.

ii) Seismic withstand test.

iii) Thermal stability test, i.e. application of rated voltage and rated extended thermal current simultaneously by synthetic test circuit. (not applicable for SF6 filled CT)

iv) Thermal co-efficient test i.e. measurement of tan delta as a function of temperature (at ambient and between 80^{O}C & 90^{O}C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um/□3) (not applicable for SF6 filled CT)

v) The current transformer shall be subjected to Multiple chopped impulse test (not applicable for SF6 filled CT) by any one of the following two methods given below to assess the CT performance in service to withstand the high frequency over voltage generated due to closing & opening operation of isolators. Alternatively, method as per IEC:60044-1 may be followed:

Method I*: 600 negative polarity lightning impulses chopped on crest will be applied to current transformer. The opposite polarity amplitude must be limited to 50% of crest value when the wave is chopped. One impulse per minute shall be applied and every 50 impulse high frequency currents form the windings and total current to earth will be recorded and be compared with reference currents recorded applying one or more (max 20) reduced chopped impulses of 50% of test value.*

Oil samples will be taken before and 3 days after the test. Gas analysis must not show appreciable rate of increase in various gases related with the results of the analysis performed before test.

Total sum of crest values of current through secondaries must not exceed 5% of the crest value of total current to earth.

CT must withstand dielectric tests after this test to pass the test.

***Method II**: 100 negative polarity impulses with a rise and fall time of less than 0.25 microsecond corrected to atmospheric condition shall be applied at one minute interval and total current through insulation of earth will be recorded. The amplitude of first opposite polarity should be limited to 50% of the chopped impulse crest value. Voltage and total current wave shapes shall be recorded after every 10 impulses, and will be compared with reference wave shapes recorded before test at 50% of test values.*

Oil sample shall be taken before and 3 days after the test and CT shall be deemed to have passed the test if the increase in gas content before and after test is not appreciable.

b) **Voltage transformers:**

i) High frequency capacitance and equivalent series resistance measurement (as per IEC-60358) for CVT.

ii) Seismic withstand test.

iii) Stray capacitance and stray conductance measurement of the low voltage terminal (as per IEC-60358) for CVT.

iv) Determination of temperature coefficient test (as per IEC-60358).

v) Radio interference voltage test as per IEC-60044-5/IEC-60044-2. However the RIV level shall be as specified in clause Major Technical Parameters in Section-GTR.

vi) Apart from the above, report of all special tests mentioned in IEC-60044-5 for Capacitive voltage transformer shall also be submitted for approval.

6.3 The current and voltage transformer shall be subjected to the following routine tests in addition to routine tests as per IEC.

a) **CURRENT TRANSFORMERS:**

ROUTINE TESTS:

<u>for Oil filled CTs</u>

i) Measurement of Capacitance.

ii) Oil leakage test.

iii) Measurement of tan delta at 0.3, 0.7, 1.0 and 1.1 Um/□3.

<u>for SF6 filled CTs</u>

i) Dew point measurement

ii) SF6 alarm/ lockout check.

iii) SF6 leakage test. Gas leakage rate shall be maintained within 0.2% per annum.

b) **VOLTAGE TRANSFORMERS:**

Routine tests on Capacitive voltage transformer shall be done in line with IEC-60044-5.

7.0 SPARE PARTS AND MAINTENANCE EQUIPMENT:

The Bidder shall include in his proposal spare parts equipment in accordance with Section-Project.

8.0 TECHNICAL PARAMETERS:

A. 245 kV CURRENT TRANSFORMERS: (Not Applicable)

A8.1	Rated Primary current	1600 A
A8.2	Rated short time thermal current	40 kA for 1 sec/50 kA for 1 sec. (as applicable)
A8.3	Rated dynamic current kA (peak)	100 / 125 (as applicable)
A8.4	Maximum temperature rise over design ambient temperature	As per IEC:60044-1
A8.5	One minute power frequency withstand voltage sec. terminal & earth	5 kV
A8.6	Number of terminals	All terminals of control circuits are to be wired upto marshaling box plus 20% spare terminals evenly distributed on all TBs.
A8.7	Type of insulation	Class A

Current transformers shall also comply with requirements of Table - IIA.

B. 145 kV CURRENT TRANSFORMERS:

B8.1	Rated Primary current	-2000/1600A / 1250A
B8.2	Rated short time thermal current	31.5 kA for 1 sec.
B8.3	Rated dynamic current	80 kA (peak)
B8.4	Maximum temperature rise over design ambient temperature	As per IEC:60044-1
B8.5	One minute power frequency withstand voltage sec. terminal & earth	5 kV
B8.6	Number of terminals	All terminals of control circuits are to be wired upto marshaling box plus 20% spare terminals evenly distributed on all TBs.
B8.7	Type of insulation	Class A

Current transformers shall also comply with requirements of Table – IIB/ or IIC as applicable.

D. 245 KV VOLTAGE TRANSFORMERS:

D8.1	System fault level (for 1 second)	40 kA kA (as applicable)
D8.2	Standard reference range of frequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measurement
D8.3	High frequency capacitance frequency capacitance **(for CVT only)** range	Within 80% to 150% of ratedfor entire carrier
D8.4	Equivalent series resistance over the entire carrier frequency range	Less than 40 ohms **(for CVT only)**
D8.5	Stray capacitance and stray conductance of the LV terminal over entire carrier frequency range	As per IEC:358 **(for CVT only)**
D8.6	One minute power frequency withstand voltage:	

	i) Between LV (HF) terminal and earth terminal	10 kV (rms) for exposed terminals and 4 KV (rms) for terminals enclosed in a weather proof box
	ii) For secondary winding	3 kV (rms)
D8.7	Maximum temperature rise over design ambient temperature	As per IEC:60044-2 or 60044-5
D8.8	Number of terminals in control cabinet (interpole cabling is to be supplied by Purchaser)	All terminals are wired upto marshaling box plus 12 terminals exclusively for Purchaser's use.
D8.9	Rated Total Thermal burden (VA)	300 (100VA/winding)

Voltage Transformers shall also comply with the requirements of Table-IA of this Section.

E. 145 KV VOLTAGE TRANSFORMERS:

E8.1	System fault level	31.5 kA for 1 second
E8.2	Standard reference range of frequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measurement
E8.3	High frequency capacitance for entire carrier frequency range	Within 80% to 150% of rated capacitance **(for CVT only)**
E8.4	Equivalent series resistance over the entire carrier frequency range	Less than 40 ohms **(for CVT only)**
E8.5	Stray capacitance and stray conductance of the LV terminal over entire carrier frequency range	As per IEC:358 **(for CVT only)**
E8.6	One minute power frequency withstand voltage:	
	i) Between LV (HF) terminal and earth terminal For secondary winding	10 kV (rms) for exposed terminals and 4 KV (rms) for terminals enclosed in a weather proof box ii) 3 kV (rms)
E8.7	Maximum temperature rise over design ambient temperature	As per IEC:60044-2 or 60044-5

E8.8	Number of terminals in control cabinet (interpole pole cabling is to be supplied by Purchaser)	All terminals are wired upto marshaling box plus 12 terminals exclusively for Purchaser's use.
E8.9	Rated Total Thermal burden (VA)	300 (100VA/winding)

Voltage Transformers shall also comply with the requirements of Table-IB of this Section.

9.0 PRE-COMMISSIONING TESTS

9.1 An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

9.2 **Current Transformers**

(a) Insulation Resistance Test for primary and secondary.

(b) Polarity test

(c) Ratio identification test - checking of all ratios on all cores by primary injection of current.

(d) Dielectric test of oil (wherever applicable).

(e) Magnetizing characteristics test.

(f) Tan delta and capacitance measurement

(g) Secondary winding resistance measurement

(h) Contact resistance measurement (wherever possible/accessible).

(i) Test for SF6 (for SF6 filled CTs) – Dew point measurement, SF6 alarm/ lockout check.

(j) DGA test of oil.

Dissolved gas analysis to be carried out at the time of commissioning. CTs must have adequate provision for taking oil samples from the bottom of the CT without exposure to atmosphere. Bidder/Manufacturer shall recommend the frequency at which oil samples should be taken and norms for various gases in oil after being in operation for different durations. Bidder/Manufacturer should also indicate the total quantity of oil which can be withdrawn from CT for gas analysis before refilling or further treatment of CT becomes necessary.

9.3 Voltage Transformers/Capacitive Voltage Transformers

(a) Insulation Resistance test for primary (if applicable) and secondary winding.

(b) Polarity test

(c) Ratio test

(d) Dielectric test of oil (wherever applicable).

(e) Tan delta and capacitance measurement of individual capacitor stacks.

(f) Secondary winding resistance measurement.

TABLE - IA

REQUIREMENTS OF 245 KV CAPACITIVE VOLTAGE TRANSFORMERS

S.No.	PARTICULAR			
1.	Rated primary voltage (kV rms)	245		
2.	Type	Single phase capacitor VT		
3.	No. of secondaries	3		
4.	Rated voltage factor	1.2 continuous		
		1.5 - 30 seconds		
5.	Phase angle error	± 10 minutes (For metering core)		
6.	Capacitance (pf)	4400/8800 (As applicable)	+ 10% - 5%	
		Secondary I	Secondary II	Secondary III
7.	Voltage Ratio	220/0.11	220/0.11	220/0.11
8.	Application	Protection	Protection	Metering
9.	Accuracy	3 P	3 P	0.2
10.	Output burden (VA) (minimum)	50	50	50

TABLE - IB

REQUIREMENTS OF 145 KV CAPACITIVE VOLTAGE TRANSFORMERS

S.No.	PARTICULAR			
1.	Rated primary voltage (kV rms)	145		
2.	Type	Single phase capacitor VT		
3.	No. of secondaries	3		
4.	Rated voltage factor	1.2 continuous		
		1.5 - 30 seconds		
5.	Phase angle error	± 10 minutes (For metering core)		
6.	Capacitance (pf)	8800	+ 10%/-5%	
		Secon-dary I	Secon-dary II	Secon-dary III
7.	Voltage Ratio	132/0.11	132/0.11	132/0.11
8.	Application	Protec-tion	Protec-tion	Meter-ing
9.	Accuracy	3 P	3 P	0.2
10.	Output burden (VA) (minimum)	50	50	50

TABLE - IIA
REQUIREMENTS FOR 245 KV CURRENT TRANSFORMERS

No.of Cores	Core No.	Appli-cation	Current ratio	Output burden (VA)	Accuracy class as per IEC: 44-1	Min. knee pt.volt-age (Vk)	Max. CT sec.wdg. resist-ance(ohms)	Max. Excit-ation cur-rent at Vk (in mA)
5 CHECK	1	BUS DIFF 800/1	1600-800/1 Tap	-	- 800 Tap; 50 on 800/1 Tap	1600/	8/4 1600/1	25 on 1600/1 Tap; 50 on 800/1 Tap
MAIN	2	BUS DIFF 800/1	1600-800/1	-	- 800 Tap; 50 on 800/1 Tap	1600/	8/4 1600/1	25 on 1600/1 Tap; 50 on 800/1 Tap
	3	METERING	1600-800/1	20	**0.2S**	-	-	-
	4	TRANS. BACK UP/LINE PROTN.	1600-800/1	-	-	1600/ 800	8/4	25 on 1600/1 Tap; 50 on 800/1 Tap
	5	TRANS. DIFF/LINE PROTN	1600-800/1	-	-	1600/ 800	8/4	25 on 1600/1 Tap; 50 on 800/1 Tap

All relaying CTs shall be of accuracy class TPS as per IEC 60044-1

TABLE - IIB

REQUIREMENTS FOR 145 KV CURRENT TRANSFORMERS

No.of Cores	Core No.	Appli-cation	Current ratio	Output burden (VA)	Accuracy class as per IEC: 44-1	Min. knee pt.volt-age Vk	Max. CT sec.wdg. resist-ance(ohms)	Max. Excit-ation cur-rent at Vk (in mA)
5	1	BUS DIFF CHECK	1600-800/1	-	-	1600/ 800	16/8	25 on 1600/1 Tap; 50 on 800/1 Tap
	2	BUS DIFF MAIN	1600-800/1	-	-	1600/ 800	16/8	25 on 1600/1 Tap; 50 on 800/1 Tap
	3	METERING	1600-800/1	20	**0.2S**	-	-	-
	4	TRANS. BACK UP/LINE PROTN.	1600-800/1	-	-	1600/ 800	16/8	25 on 1600/1 Tap; 50 on 800/1 Tap
	5	TRANS. DIFF/LINE PROTN	1600-800/1	-	-	1600/ 800	16/8	25 on 1600/1 Tap; 50 on 800/1 Tap

c

All relaying CTs shall be of accuracy class T PS as per IEC 60044-1.

NOTE: The ratio and ratings of the instrument transformer will be finalized during Detail Design Engineering.

TABLE – II C

REQUIREMENTS FOR 145 kV CURRENT TRANSFORMERS

No.of Cores	Core No.	Appli-cation	Current ratio	Output burden (VA)	Accuracy class as per IEC: 44-1	Min. knee pt.volt-age Vk	Max. CT sec.wdg. resist-ance(ohms)	Max. Excit-ation cur-rent at Vk (in mA)
5	1	BUS DIFF CHECK	2000-1000/1	-	-	2000/ 1000	2/1	25 on 1200/1 Tap; … on 800/1 Tap
	2	BUS DIFF MAIN	2000-1000/1	-	-	2000/ 1000	2/1	25 on 1200/1 Tap; .. on 800/1 Tap
	3	METERING	200-400/1	20	**0.2S**	-	-	-
	4	TRANS. BACK UP/LINE PROTN.	200-400/1	-	-	200/ 400		Tap; .. on Tap
	5	TRANS. DIFF/LINE PROTN	200-400/1	-	-	200/ 400		n Tap; .. on Tap

All relaying CTs shall be of accuracy class TPS as per IEC 60044-1.

NOTE: The ratio and ratings of the instrument transformer will be finalized during Detail Design Engineering.

CHAPTER 3.1 - SWITCHGEAR

SURGE ARRESTERS

CONTENTS

CHAPTER 3.1 - SWITCHGEAR

SURGE ARRESTERS

1.0 GENERAL:

1.1 The Surge arresters shall conform to IEC: 60099-4 except to the extent modified in the specification and shall also be in accordance with requirements under Chapter 2 -GTR.

1.2 Arresters shall be of hermetically sealed units, self supporting construction, suitable for mounting on tubular support structures to be supplied by the Contractor.

1.3 The Surge Arrestors shall be designed for use in the geographic and meteorological conditions as given in the Chapter 2 -GTR.

2.0 DUTY REQUIREMENTS:

a. The surge arresters shall be of heavy duty station class and gapless type without any series or shunt gaps.

b. The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.

c. 245/145 kV class arrester shall be capable for discharging energy equivalent to class 3 of IEC for 245/145/12 kV system on two successive operations.

d. The surge arresters shall be suitable for withstanding forces as defined in Chapter 2-GTR.

e. The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

f. The surge arresters are being provided to protect the following equipment whose insulation levels are indicated in the table given below:-

Equipment to be protected	Lightning impulse(kVp) for 245 kV system	Lightning Surge for 145 kV system
Power transformer	± 950	± 550
Instrument Transformer	± 1050	± 650
Reactor	--	--

CB/Isolator Phase to ground	± 1050	± 650
CB/Isolator Across open contacts	± 1050(for CB) ± 1200(for Isolator	± 750

g. The duty cycle of CB installed in 245/145 kV System of the Purchaser shall be O-0.3 sec-CO-3 min-CO. The Surge Arrester shall be suitable for such circuit breaker duties in the system.

3.0 CONSTRUCTIONAL FEATURES:

The features and constructional details of surge arresters shall be in accordance with requirement stipulated hereunder:

a) The non-linear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

b) The surge arresters shall be fitted with pressure relief devices suitable for preventing shattering of porcelain housing and providing path for flow of rated fault currents in the event of arrester failure. Details shall be furnished in the bids alongwith quality checks.

c) The arresters shall not fail due to arrester porcelain contamination.

d) Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

e) Outer insulator shall be porcelain/polymer conforming to requirements stipulated in Chapter 2-GTR. Terminal connectors shall conform to requirements stipulated under Chapter 2-GTR.

The outer insulator housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrester.

f) The end fittings shall be made of corrosion proof material and preferably be nonmagnetic.

g) The name plate shall conform to the requirements of IEC incorporating the year of manufacture.

h) The heat treatment cycle details alongwith necessary quality checks used for individual blocks alongwith insulation layer formed across

each block are to be furnished. Metalizing coating thickness for reduced resistance between adjacent discs is to be furnished with additional information schedule of bid proposal sheets alongwith procedure for checking the same. Details of thermal stability test for uniform distribution of current on individual disc is to be furnished.

i) The manufacturer will submit Data for rejection rate of ZnO blocks during manufacturing/operation for the past three years.

j) The sealing arrangement of the Surge Arrester stacks shall be done incorporating grooved flanges with the O-rings/elliptical cross-section gaskets of Neoprene or Butyl rubber.

k) The Surge arrester with porcelain housing shall have a cantilever strength of not less than 350 kg for 216/120kV surge arresters respectively or as per the value obtained vide Chapter 2-GTR, whichever is higher. For Surge arrester with polymer housing, the cantilever strength shall not be less than 150kg.

4.0 FITTINGS AND ACCESSORIES:

a) 216/120 kV Arresters shall be complete with insulating base and Surge monitor having provision for bolting to flat surface of structure.

b) Self contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit alongwith necessary connection. Suitable leakage current meters should also be provided. The reading of milliammeter and counters shall be visible through an inspection glass panel. The terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The surge counter shall be provided with a potential free contact rated for 220 V (DC) which shall close whenever a surge is recorded by the surge monitor. Necessary arrangement shall be provided for extending the contact information to substation automation system.

c) Surge monitor consisting of discharge counters and milliammeters should be suitable to be mounted on support structure of the arrester and should be tested for IP66 degree of protection. The standard supporting structure for surge arrester should be provided with a mounting pad, for fixing the surge monitor. The surge monitor should be suitable for mounting on this standard mounting pad. Also all nuts, bolts, washers etc. required for fixing the surge monitor shall have to be supplied by the Contractor.

The arrangement for Surge Monitor enclosure fixing to the structure shall be at its rear/bottom. Connection between the Surge Arrester base and Surge Monitor shall be through a 2.0 m(minimum) long insulated copper rod/strip of at least 75 sq.mm cross sectional area. The cable shall be terminated at rear/bottom side of the Surge Monitor. The gaskets of the surge monitors shall be of Neoprene, Butyl or equivalent material.

d) Grading/corona rings shall be provided on each complete arrester unit as required. Suitable terminal connectors shall be supplied by the Contractor.

5.0 TESTS:

5.1 **In accordance with the requirements stipulated under Chapter 2-GTR, the surge arresters should have been type tested as per IEC and shall be subjected to routine and acceptance tests in accordance with IEC document For contamination test, procedures outlined in 60099-3 shall be followed.**

The test reports of the type tests and the following additional type tests(additional type tests are required for Surge Arresters above 72.5 kV class only) shall also be submitted for the Purchaser's review.

i) Radio interference voltage test as per IEC 60099-4.

ii) Seismic withstand test.

iii) Accelerated ageing test.

iv) Test to verify the Power frequency versus time characteristics. Temporary over voltage profile for arresters are to be mutually agreed.

Each metal oxide block of surge arresters shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC: 60099-4.

5.2 (a) **Acceptance Tests:**

1. Measurement of power frequency reference voltage of the arrester units.

2. Lightning Impulse Residual voltage on arrester units. (IEC clause 6.3.2).

3. Internal Ionisation or partial Discharge test.

(b) **Special Acceptance Test:**

1. Thermal stability test on three sections. (IEC Clause 7.2.2).

2. Aging test for Zinc oxide Blocks as an acceptance test is to be carried out on 3 samples for 72 hours at maximum continuous over voltage (MOCV) and at a temperature of 115 degree C. Acceptance norm being Ir (resistive current)/ watt loss shall remain same or decrease at the end of 72 hous from the value taken after 1 hour of start of test.

3. Wattloss test.

(c) **Routine Tests:**

1. Sealing test: Water dip test at 1.5m depth from top of Surge Arrestor for 30 minutes shall be performed during assembly of Surge Arrester stacks (followed by other routine tests, i.e. P.D. Measurement, Reference Voltage, Residual Voltage & IR measurement).

2. Measurement of reference voltage.

3. Residual voltage test of arrester unit.

4. Internal Ionisation test or partial discharge test.

5. Verticality check on completely assembled Surge arresters as a sample test on each lot.

(d) **Test on Surge Monitors:**

The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/ functional tests with one 100A and 10kA current impulse (8/20 micro sec.) shall also be performed on the Surge monitor.

Surge monitors shall be routinely tested for water dip test at 1.5m for 30 minutes. No water vapors shall be visible on the monitor glass.

(e) **Test on insulators**

All routine tests shall be conducted on the hollow column insulators as per IEC 62155. Polymer housing shall be tested in accordance to IEC-61462.

6.0 SPARE PARTS AND MAINTENANCE EQUIPMENT:

Bidder shall include in his proposal spare parts and maintenance equipment, as mentioned in Chapter 1-PSR.

7.0 TECHNICAL PARAMETERS:

A. 245 kV CLASS SURGE ARRESTER

A7.0(a)	Rated arrester voltage	216 kV
A7.0(b)	Nominal discharge current	10 kA of 8/20 microsecond wave
A7.0(c)	Minimum discharge capability	5kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics.
A7.0(d)	Continuous operating voltage at 50 deg.C	168 kV rms
A7.0(e)	Max. switching surge residual voltage (1kA)	500 kVp
A7.0(f)	Max. residual voltage at	
	i) 5 kA	560 kVp
	ii) 10 kA nominal discharge current	600 kVp
A7.0(g)	Max. steep current impulse residual voltage at 10 kA.	650 kVp
A7.0(h)	Long duration discharge class	3
A7.0(i)	High current short duration test value (4/10 micro second wave)	100 kAp
A7.0(j)	Current for pressure relief test	40 kA rms / 50 kA rms (as applicable)
A7.0(k)	Low current long duration test value (2400 micro sec)	As per IEC.
A7.0(l)	Pressure relief class	40 kA / 50 kA (as applicable)

B. 145 kV CLASS SURGE ARRESTER

B7.0(a)	Rated arrester voltage	120 kV
B7.0(b)	Nominal discharge current	10 kA of 8/20 microsecond wave
B7.0(c)	Minimum discharge capability	5kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics.
B7.0(d)	Continuous operating voltage at 50 deg.C	102 kV rms
B7.0(e)	Max. switching surge residual voltage (1kA)	280 kVp
B7.0(f)	Max. residual voltage at	
	i) 5 kA	310 kVp
	ii) 10 kA nominal discharge current	330 kVp
B7.0(g)	Long duration discharge class	3
B7.0(h)	High current short duration test value (4/10 micro second wave)	100 kAp
B7.0(i)	Current for pressure relief test	40 kA rms
B7.0(j)	Low current long duration test value (2400 micro sec)	As per IEC.
B7.0(k)	Pressure relief class	31.5 kA

C 11kV Surge Arresters

C7.0(a)	Rated arrester voltage	9 kV
C7.0(b)	Nominal discharge capability	10 kA of 8/20 microsecond wave
C7.0(c)	Minimum discharge	4kJ/kV (referred to rated

	capability	arrester voltage corresponding to minimum discharge characteristics).
C7.0(d)	Continuous operating voltage at 50 deg.C	7.2 kV rms
c7.0(e)	Max. switching surge residual voltage (0.5kA)	22.4 kVp
C7.0(f)	Max. residual voltage	
	(i) 5 kA	26 kVp
	(ii) 10 kA nominal discharge current	28 kVp
C7.0(g)	Long duration discharge class	2
C7.0(k)	Pressure relief class	25k A

8.0 PRE-COMMISSIONING TESTS

8.1 An indicative list of tests is given below.

(a) operation check of LA counter.

(b) Insulation resistance measurement

(c) Capacitance and Tan delta measurement of individual stacks.

(d) Third harmonic resistive current measurement (to be conducted after energization.)

Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

CHAPTER - 4
A.C. and DC DISTRIBUTION BOARD

1.0 SCOPE

1.0.1 These specifications are intended to cover the design, engineering, manufacturing, inspection and testing at manufacturer's works, packing, supply & delivery, Testing & commissioning of 400 volts, 3 phase, 4 wire, AC distribution switch boards cubical in-door type complete with all materials, accessories and fittings, erection & maintenance tools & tackles, mandatory spares as detailed in this specification.

1.0.2 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life.

1.0.3 Any material and equipment not specifically stated in this specification but which are necessary for satisfactory operation of the equipment shall be deemed to be included unless specifically excluded and shall be supplied without any extra cost.

1.1 STANDARDS

1.1.1 The equipment covered by this specification shall confirm to the provisions of the following IEC/International standards as amended up to date except where specified otherwise in this specification.

The Equipment and material meeting the requirement of any other Indian standards or internationally recognized standards which ensure a quality equal or better than the standard mentioned above shall also be acceptable. Where the equipment confirms to any other standards then salient points of difference between the standards adopted and those prescribed in these specifications shall be clearly brought out in the bid and a copy of the applicable standards shall also be enclosed by the bidder with the bid.

1.2 DESCRIPTION

1.2.1 The LT AC Distribution Board shall be fed from 315 KVA, 11kV/400 V distribution transformer.

1.2.2 Tentatively the following minimum feeders shall be required from the AC Distribution Board, and each shall be suitably rated as per requirement.

a. Incoming from the Station Transformers i.e. 4 wire, 3 phase supply.
b. 3 phase, 4 wires supply for oil filtration set.
c. Single phase supply to various 132 kV Circuit Breakers (separate feeders to each).
d. 3 phase, 4 wires supply for indoor lighting.
e. 3 phase, 4 wires supply for outdoor lighting.
f. 3 phase, 4 wires for transformer Marshalling boxes.

g. 1 phase supply to 33 kV switchgear panel board.

h. 1 phase supply to 132 kV C&R Panels.

i. 1 phase supply to Substation Automation System, HMI, printers etc.

j. 1 phase supply to 132 kV isolator boxes for motor operation.

k. 3 phase, 4 wires feeders for Battery chargers.

l. Supply for OPGW Communication Panel.

m. At least 20% (minimum 1) of each rating as spares.

n. Three phase/single phase supply as per requirement with individual MCCB/MCB's to Air conditioning system, Fire detection, alarm and control system, etc.

1.2.3 Incoming from transformer shall be provided with the following:

a. Suitable MCCBs (with adjustable setting) with O/L & S/C releases

b. One No. 100 mm dia. flush mounted Ammeter with range 0-600 amp with phase selector switch.

c. One No. 100 mm dia. flush mounting voltmeter scale range 0-500 V with fuse and selector switch, along with LED type, indicating lamps before the selector switch.

d. Suitable CTS having burden 25 VA and accuracy class – I

e. One No. 3 phase, 4 wires unbalanced load integrating watt – load meter operable on CT. Each circuit as indicated above shall have switch rating and labeling as mentioned against each and shall include bus-bar connections, terminals cable glands and legs etc.

f. Bus bar shall be of Aluminum and designed for 630 Amps for phases and 400A for neutral.

1.2.4 400VAC switch board cubical type shall consist of feeders as above and shall have MCBof rating and labeling as per system requirement. It shall include bus-bar connections terminals, Cable glands and lugs. The aluminum bus- bar shall be designed for 630 Amps for phases and 400 Amp for neutral based current density of 85 Amp per sq. cm. The bidder shall design the ratings of MCB/MCCBs' which shall be approved by purchaser. The above detail of outgoing feeders is provisional and is subject to change during detailed engineering.

1.2.5 The A.C. Board shall be fitted with the following accessories:

1. 230 V, AC space heater with MCB and thermostat.
2. Only MCB/MCCBs' as appropriate shall be provided. No fuses are allowed.
3. All the feeders shall be provided with single phase ammeters. For three phase supplies an ammeter with selector switch (or in yellow phase only) shall be provided. Typical ammeter size shall be 70 mm x 70 mm. These details shall be finalized during detailed engineering.

4. Necessary CTs wherever required for current measurement shall be provided. The secondary rating of each shall be 1A.
5. Indicating lamps shall be of low wattage typically 2.6 W or less.
6. All the terminals for external cabling shall be suitably rated as per the size of the external cables.
7. All the indicating instruments, lamps, handles, MCCBs', MCB's shall be flush mounted.
8. Panel shall be indoor, single front, fixed type.
9. Base frame shall be of ISMC-100.
10. Phase clearances shall be as per IS/IEC.
11. Panel Paint: will be decided during detailed engineering
12. Interior & mounting plate: Glossy white
13. Bus bars to be colour coded and also the circuits taken from it.
14. Earth bus of 50 x 6mm copper strip shall project out of the panel at both ends and shall have two holes for earth connections.
15. Control Wiring: 1.5 mm^2 copper (48 strands), 2.5 mm^2 copper for CTs (48 strands)
16. Power Switch & MCCB shall be door interlocked and shall have pad locking
17. Caution Name Plates for live terminals shall be provided.

DC DISTRIBUTION BOARD

1.3.1 The DC Distribution Board for both 110V and 48V system shall be fed from respective Battery Charger.

1.3.2 Tentatively the following minimum feeders shall be required from the DC Distribution Board, and each shall be suitably rated as per requirement.

a. Incoming 2 Nos with change-over facility from the battery chargers i.e. 4 wire, 3 phase supply.
b. Supply to various 132 kV Circuit Breakers, Disconnectors etc (separate feeders to each).
c. supply to 11 kV switchgear panel board.
d. supply to 132 kV C&R Panels.
e. supply to Substation Automation System, HMI, printers etc.
f. Supply for Communication Panel.
g. Emergency lighting
h. Others required services
i. At least 20% (minimum 1) of each rating as spares.

1.2.6 The switch board cubical type shall consist of feeders as above and shall have MCB of rating and labeling as per system requirement. It shall include bus-bar connections terminals,

Cable glands and lugs. The aluminum bus- bar shall be designed to cater the current as required by the capacity of the battery charger and loads. The bidder shall design the ratings of MCB/MCCBs' which shall be approved by purchaser. The above detail of outgoing feeders is provisional and is subject to change during detailed engineering.

1.2.7 The A.C. Board shall be fitted with the following accessories:

18. 230 V, AC space heater with MCB and thermostat.
19. Only MCB/MCCBs' as appropriate shall be provided. No fuses are allowed.
20. All the feeders shall be provided with ammeters.
21. Indicating lamps shall be of low wattage typically 2.6 W or less.
22. All the terminals for external cabling shall be suitably rated as per the size of the external cables.
23. All the indicating instruments, lamps, handles, MCCBs', MCB's shall be flush mounted.
24. Panel shall be indoor, single front, fixed type.
25. Base frame shall be of ISMC-100.
26. Phase clearances shall be as per IS/IEC.
27. Panel Paint: will be decided during detailed engineering
28. Interior & mounting plate: Glossy white
29. Bus bars to be colour coded and also the circuits taken from it.
30. Earth bus of 50 x 6mm copper strip shall project out of the panel at both ends and shall have two holes for earth connections.
31. Control Wiring: 1.5 mm^2 copper (48 strands), 2.5 mm^2 copper for CTs (48 strands)
32. Power Switch & MCCB shall be door interlocked and shall have pad locking
33. Caution Name Plates for live terminals shall be provided.

1.3 CONSTRUCTIONAL FEATURES

1.3.1 Station Supply LT Board

The supply board shall comprise of:

a. Metal enclosed, indoor /outdoor mounted, dust and vermin proof and self-supporting cubicle type made –up of mild steel sections and cold rolled sheet steel of 2 mm thickness for enclosure and all load bearing members, doors & fitting plate. The Gland Plate shall be 3 mm thick, sheet steel, with double compressions, chromium plated brass glands.

b. The board shall be stiffened properly to be free from vibration, twist and bends. The degree of protection of enclosure to be not less than IP-54 for all indoor type panels

and IP-55 for all outdoor mounted panel or boards respectively as stipulated by relevant IEC.

c. Requisite number of sheet steel enclosure for mounting circuit breakers, relays, switches, CTs and other components. Light structural members shall be jointed preferably by bolting.

d. Separate cable / bus- bar chambers duly partitioned, removable covers and metals still frames of single front double access type having feeders located in the front and vertical bus bars and cable chamber located in the rear.

e. Detachable or hinged type door with handle and locking arrangements and easy access for inspection and maintenance works.

f. Bottom frame suitable for erection on flush concrete floor by means of evenly spaced grouting bolts projecting through the base channel members.

g. Necessary facilities for entry of cable from the bottom. No access to any live part inside the panel to avoid accident. Separate cable support to avoid load on the thimble of cable as well as on the links.

h. Synthetic rubber Gaskets all-round the perimeter of cover, gland plates, removable covers and doors shall be provided.

i. Eye bolts at the top to facilitate lifting and anti-vibration pads between base frame and panel to prevent vibration.

j. Adequate strength to withstanding all stresses imposed during handling, transportation, installation and operation without distortion or damage. The panels shall be assembled to the extent possible within transporting and handling limitations duly wired up and ready for installation in accordance with this specification.

k. Each MCB to have separate bus –link wired up to terminal block so that by removal of link, the outgoing feeder is isolated without removing cable from the terminals.

l. The minimum component height will be 250 mm form the ground level for case of maintenance.

m. It must be ensured while designing the switch boards that adequate electrical clearance as required under the rules shall be provided for the various components inside the cubical.

1.3.2 Distribution Board

a. The boards shall be fabricated out of best quality cold rolled sheet steel of 2 mm including for doors & sides and shall be fully dust and vermin proof affording a degree of protection of IP – 54 for indoor DBs and IP 55 for outdoor DBs as per IS – 2174.

b. Distribution boards shall be provided both hinged door with handle and looking facility for switch on inter lock facility for switch on interlock of doors. Doors shall be gasketted all round with neoprene gaskets.

c. All accessible live connections / parts shall be shrouded and it shall possible to change /replace individual MCB /Fuse units from the front of the board without danger & coming in to contact with live parts.

d. Adequate interior cabling space and suitable removable type cable entry plates shall be provided for top/ bottom entry of cable gland plate shall be supplied undrilled. Necessary number of glands to suit the specified cable shall be provided. Cable glands shall be screwed on type and made of chromium plated brass.

e. The DB shall have two earthing terminals for connecting to the stations earthing.

f. The AC and DC DBs shall be either floor mounted type. Suitable foundations channels with necessary bolts and nuts shall be provided.

g. The danger board shall be fixed on the front of the door of DBs as per standards.

h. Wiring inside the panel shall be carried out with 1100 V grade PVC insulated stranded copper conductors of adequate size on both ends of each wire engraved identification ferrules shall be provided.

i. Bus bar shall be of copper adequately sized for the specified continuous current rating such that the maximum temperature of the busbar and links does not exceed 75^0 C.

j. All MCBs /Isolators /switches etc. shall be flush mounted with hinged door provided with locking arrangement and an inner Bakelite sheet /fibre glass sheet shall be provided inside such accidental contact.

k. Equipment mounted inside the panel shall be provided with individual labels with equipment designation /rating. Front of the panel shall be provided with label engraved with designation of the panel as furnished by the purchaser. Label shall be made of 3 ply lamicold /engraved PVC having white letters on black ground. Letter size shall be 4 mm minimum.

l. Terminal blocks shall be 1100 V grade clip on type, molded in melamine suitable for terminating incoming cable of suitable size of stranded copper conductor and outgoing circuits of approved sizes. All the terminals shall be shrouded, numbered and provided with identification strip for the feeders.

m. MCB's shall be current limiting type magnetic and thermal release suitable for manual closing and automatic tripping under fault condition single pole MCB's shall have interrupting capacity not less than 10 kA. MCB knob shall be marked with ON/OFF indication. A trip free release shall be provided to ensure tripping on

fault even if the knob is held in on position to avoid accidental contact. MCCB shall have adjustable setting, O/L & S.C. releases.

n. Fuses if required shall be HRC cartridge type complete with fuses fittings. Fuses fittings shall incorporate fully insulated shrouded contacts. Visible indication of operation of fuses shall be provided. However, purchaser would not prefer to have fuses instead MCB's should be provided.

o. The indoor panel shall be finalized during detailed engineering. The inside of the panel shall be glossy white.

1.4 PAINTING

a. All sheet work shall be phosphate in accordance with following procedure and in accordance with IS/IEC, code of practice for phosphating iron and steel, with seven tank process.

b. Oil, grease and dirt shall be thoroughly removed by emulsion cleaning.

c. Rust and scale shall be thoroughly removed by emulsion cleaning.

d. Rust and scale shall be removed by pickling with dilute acid followed by washing and running water rinsing with slightly alkaline hot water and drying.

e. After phosphating, through rinsing shall be carried out by clean water followed by final rinsing with dilute solution and oven drying.

f. The phosphate coating shall be sealed by the application of two coats of red mixed stoving type Zinc chromate primer. The coat may be 'flash dried' while the second coat shall be stove dried.

g. After the application of the primer, two coats of finishing synthetic enamel shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests. The color of the finishing paint on the exterior should be got approved form the purchasers before painting. All the panels and DBs shall be painted white in the interior.

h. Each coat of primer and furnishing paint shall be of a slightly different shade to enable inspection of painting.

i. The final finished film thickness of paint on sheet steel shall not be less than 100 microns and shall not be more than 150 microns.

j. Finished painted appearance shall present an aesthetically pleasing appearance free from dents and uneven surface.

k. Adequacy quantity of finishing paint shall be supplied for minor touchup required at site after the installation of the L.T., AC station board and distribution boards.

1.5 BUS – BAR, SWITCHING DEVICES & CONNECTIONS

1.5.1 LT Station Supply Board

Bus bar system for LT station supply board shall be assembled and fully tested and certified in accordance with relevant standards i.e. IS :375 or BS : 5486 & IEC 439

The busbars of LT station supply boards shall be of high conductivity aluminum and of uniform rectangular cross section. The size of bus bar shall be got approved from the purchaser before the procurement /fabrication. The bus bars and supporting arrangements shall be designed to withstand thermal and magnetic stresses corresponding to 10 kA fault level. All bus bars and metallic bus supports shall be insulated by heat shrunk PVC sleeves with exceptional dielectric properties to provide additional protection against accidental contact and to prevent failure in the event of accidental presence of external agents. Bus bars supports shall be arc resistant flame retardant, porcelain type or sheet moulding compound having high insulation resistance and de-moulding compound having high insulation resistance and dielectric strength to avoid ground faults of bus due to dust collection. At the bus- bar joints and tap-off points, removable shrouds (sleeves) shall be provided. Temperature rise shall not exceed the maximum allowable temperature for the equipment as specified in relevant IS/IEC specification even under over load conditions and shall be of sufficient size to limit the temperature rise not to exceed the specified value in the applicable standard inside the enclosure. Ground bus shall be provided at the bottom of each station supply board throughout the entire length of the board. This bus shall be earthed solidly by connecting to the main earthling system of the sub- station. There should be provision for earthing at both ends of the switchboard Lugs, bolts, nuts and spring washers shall be provided for earth connection.

1.5.2 Distribution Board

These shall be provided whenever required to further distribute the three phase supply taken from the ACDB. The bus bars of distribution boards shall be of electrolytic copper having 99.9 % purity as per IS-440 unless otherwise specified. The size of the Bus bars be got approved form the purchaser during detailed engineering.

a) All bus bars, MCBs, Switch fuse units, fuses and connection shall be of sufficient size to limit the temperature not to exceed the specified value in the relevant standard inside the enclosure while carrying full load current. All main busbars connections and bus bar outgoing taps be tin plated and tightly clamped with through bolts to ensure maximum conductivity. All bus bars shall be rigid type. All bus bars connections shall be accessible for inspection and maintenance purpose.

b) Bus bars supports shall be made of suitable insulating material such as sheet moulding compound, glass reinforced moulded plastic material, or cast resin etc., of

thickness not less than 6 mm. Separate supports shall be provided for all three phases, anti – tracking barriers shall be incorporated.

c) The bus bars shall be protected from Accidental contact by using highly not less than 6 mm thick.

d) The size of neutral bus of the wall mounted type 3 phase 4 wire distribution board shall be rated as the phase bus-bars. The neutral bus should have sufficient terminals and detachable links for all the single phase outgoing and supports shall have sufficient strength to with stand thermal and electromechanical stresses for a short circuit level of 10 kA of the system.

1.6 MOULDED CASE CIRCUIT BREAKERS (MCCB)

The MCBs shall be of reputed make having proven performance record with minimum rupturing capacity of 10 kA. The MCCBs shall be quick make quick break, independent manual type trip free mechanism. Position of knob shall be provided to test trip the MCCBs mechanically. Overload and short circuit protection for all circuits shall be provided for MCCBs. The MCCBS shall be covered with the insulating case and covers made of high strength, high resistant and flame retardant thermosetting insulating material.

1.7 MINIATURE CIRCUIT BREAKERS (MCB)

The MCBs shall be of reputed make and the characteristics of MCB shall be suitable for control & protection circuit equipment's, high pressure mercury vapour / sodium vapor lamps / fluorescent tubes & power points etc. MCB shall be hand operated, air break, quick make, quick break confirming to applicable standards mentioned. The out-going MCBs shall be provided with overload / short circuit device for protection under overload and short circuit conditions. The MCB shall have a minimum interrupting rating of 10 kA. MCB shall be flush mounted and fitted on Zinc chromium M.S channel provided in DB construction. Single pole MCBs shall be provided for all outgoing A.C feeders.

1.8 RESIDUAL CURRENT – OPERATED CIRCUIT BREAKERS (RCCB) / EARTH LEAKAGE CIRCUIT BREAKERS (ELCB)

1.8.1 The RCCB/ELCB offered shall be suitable for particular application in conjunction with MCB and arranged for manual closing and opening and automatic tripping on earth fault condition. In case of multi-pole circuit breakers, the indication shall represent the position of all the poles. The metallic portions of the mechanism shall be either inherently resistant to or treated so as to make them resistant to atmospheric corrosion. The operating mechanism shall be trip free. The operation mechanism case shall be effectively sealed by the manufacturer to prevent access to the mechanism. The case shall be of insulating material.

1.8.2 The RCCB shall be provided with test device for testing automatic opening of the circuit breaker by an integral test device. The test device shall be arranged for external operation in such a way that the protection afforded by the cover or enclosure is not impaired.

1.8.3 The product of rated residual current (rated tripping current) in amperes and the earth loop impedance in ohm should not exceed the value 50. The RCCB shall be so chosen that the same has lowest suitable tripping current.

1.9 FUSE HOLDER /BASE

Fuse holder be suitable for HRC fuse links of required rating. They shall be made up of superior grade phenolic moulding compound with non – inflammable property. Fuses holder shall be supplied with necessary cable holding screws and terminal lug fasteners and conducting portion copper carrier with extruded brass base support. Further conducting part shall be silver plated to provide long lasting shall be complete with pressure clip so formed to provide durable firm grip of male and female parts. Fuse holder shall be fully shrouded to ensure personnel safety.

1.10 FUSES

Generally fuses shall not be used anywhere. However if approved by purchaser due to specific situation the fuses shall be of reputed make and shall be HRC Cartridge type with minimum rupturing capacity of 10 kA. The fusing factor shall be greater than 1.5 and shall be provided with visible indicator for having operated. Fuses shall be dimensionally interchangeable with any other compatible make and shall be so designed to ensure non-deteriorating time current characteristics.

1.11 INTERNAL WIRING

The LT AC and DC station supply board and the distribution boards shall be supplied with complete internal wiring. The wiring shall be carried out the 1100 V grade, PVC insulated. Stranded supper conductor cables of adequate size shall be used to suit the rated circuit current. Engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire. All wiring shall be terminated on terminal blocks. Terminal blocks shall be one piece moulded and suitable for 500 V. Stud type terminal blocks shall be used for higher current rating. Terminals shall be adequately rated for the short circuit current. Typically terminals of 'Phoenix Contact' make shall be provided which shall be approved by purchaser during detailed engineering.

1.12 NAME PLATE

Name plate shall be made of non-rusting metal or engraved on PVC shall be of size 50 mm x 20 mm indicating the feeder details and shall be provided for all feeders for easy identification DB No. etc. shall be provided.

1.13 DRAWINGS & LITERATURE

After receipts of the order, the contractor shall be required to furnish 10 prints of the following drawings for approval:-

a) General arrangements drawing of AC distribution board.
b) Typical schematic diagram of AC distribution board.
c) Complete assembly drawing of AC distribution boards showing plan, elevation. sectional views and location of terminal blocks cable entry details
d) Control and wiring diagram for each module of AC distribution board including spare terminals and inter modular and inter panel wiring.
e) Foundation plan showing location, channels, foundation bolts etc.
f) Schematic control diagram for control interlocks, relays, instruments and space heaters.
g) Protective relay characteristics of each type of relay
h) Fuse characteristics curve for each type of rating
i) Technical and descriptive literature giving details of the equipment offered.

1.14 TESTING & INSPECTION

1.14.1 All tests and inspection shall be made at the manufacturer's works unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of placement of purchase order. The manufacturer shall afford to the inspector representing the purchaser, all reasonable facilities, without charge to satisfy him that the material being furnished is in accordance with these specifications. The purchaser reserves the right to get any component/material being used by the manufacturer of the L.T. board tested from any recognized test house. No material shall be dispatched without prior approval of the all the test reports and certificates by the purchaser.

1.14.2 The inspection by the purchaser or his authorized representative shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specification.

TABLE-1.14.2.1

TECHNICAL PARTICULARS

1.	**AC SYSTEM**	3 phase, 4 wire, solidly earthed

	a. Voltage	400 volts- 15 % to +10 %
	b. Frequency	50 Hz ± 3 %
	c. Combined variation in voltage & frequency	- 10 % to + 10 % Absolute sum
	d. Fault level	10 kA (rms)
2.	**BUS BAR**	
	a. Continuous	630 A Aluminum
	b. Short time (1 Sec)	10 kA rms
3.	**ONE MINUTE POWER FREQUENCY WITHSTAND VOLTAGE**	
	a. Power circuits	2.5 kV (rms)
	b. Control circuits	2.5 kV (rms)
4.	**MOULDED CASE CIRCUIT BREAKER**	
	a. Voltage	AC 3- phases –415 V (-15 to + 10 %)
	b. Frequency	50 Hz
	c. Short circuit Performance	10 kA (rms)
	d. Making capacity	2.5 times breaking capacity
	e. Operating Mechanism	Manual , trip free
	f. Temperature rise	As per IEC
	g. Mechanical rise	As per IEC
	h. Auxiliary contacts	4 No., 4 NC
5.	**METERS**	
	a. Accuracy class	1.0 or better
	b. one minute power frequency withstand voltage	2 .5 kV (rms)
6.	**CURRENT TRANSFORMERS**	
	a. Type	Cast resin, Bar primary
	b. Secondary circuit	1 Amp.
	c. Voltage class and Frequency	1100 V, 50 Hz
	d. Class of insulation	E or better
	e. Accuracy	
	I. Accuracy class metering CT	Class 1, 10 VA

	II. Accuracy class protection CT	5p 10 , 15 VA
	f. Short time current rating	10 kA (rms) for 1 sec.
	g. one minute power frequency withstand voltage	2.5 kV (rms)
7.	**VOLTAGE TRANSFORMERS**	
	I. Type	Cast resin
	II. Rated voltage	415 V±10%
	a. Primary	415 V /√3
	b. Secondary	110V/√3
	III. Accuracy class and VA burden	
	a. Metering	1.0, 10 VA
	b. Protection	3 p, 50 VA
	IV. Method of connection	
	a. Primary	Star
	b. Secondary	Star
	V. Rated voltage factor	1.1 continuous , 1.5 for 3 sec.
	VI. Class of insulation	E or better
	VII. One minute power frequency withstand voltage	2.5 kV (rms)
8.	**RELAY**	
	a. One minute power frequency withstand voltage	2.0 kV (rms)
9.	**CUBICLE COLOUR FINISH**	
	a. Interior	Glossy white
	b. Exterior	Decided during detailed engineering
10.	**ACCESSORIES**	
	a. Plug point with switch fuse.	
	b. Space heater with thermostat	
	c. Name plate on front of rear	
	d. Danger plate	

TECHNICAL PARTICULARS

1.	**DC SYSTEM**	3 phase, 4 wire, solidly earthed
	a. Voltage	400 volts- 15 % to +10 %
	b. Frequency	50 Hz ± 3 %
	c. Combined variation in voltage & frequency	- 10 % to + 10 % Absolute sum
	d. Fault level	10 kA (rms)
2.	**BUS BAR**	
	a. Continuous	250 A Aluminum
	b. Short time (1 Sec)	10 kA rms
3.	**MOULDED CASE CIRCUIT BREAKER**	
	a. Voltage	DC 220 V/110 V (-15 to + 10 %)
	b. Short circuit Performance	10 kA (rms)
	c. Making capacity	2.5 times breaking capacity
	d. Operating Mechanism	Manual , trip free
	e. Temperature rise	As per IEC
	f. Mechanical rise	As per IEC
	g. Auxiliary contacts	4 No., 4 NC
4.	**METERS**	
	a. Accuracy class	1.0 or better
	b. one minute power frequency withstand voltage	2 .5 kV (rms)
5.	**RELAY**	
	a. One minute power frequency withstand voltage	2.0 kV (rms)
6.	**CUBICLE COLOUR FINISH**	
	a. Interior	Glossy white
	b. Exterior	Decided during detailed engineering
7.	**ACCESSORIES**	
	a. Plug point with switch fuse.	
	b. Space heater with thermostat	
	c. Name plate on front of rear	
	d. Danger plate	

CHAPTER 5: BATTERY AND BATTERY CHARGER

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CHAPTER: BATTERY & BATTERY CHARGER

1.1. GENERAL TECHNICAL REQUIREMENTS

1.1.1. All materials/components used in battery chargers and batteries shall be free from flaws and defects and shall conform to the relevant Indian/IEC standards and good engineering practice.

1.1.2. DC System shall consist of two (2) float-cum-boost chargers and one (1) battery sets for each of 110V and 48 V systems respectively or as per BPS. The standard scheme drawing is enclosed with this specification. The design shall be redundant such that while one charger is working other shall be in stand by mode.

1.1.3. Bidder shall select number of cells, float and Boost voltage to achieve following system requirement:

System Voltage	Maximum Voltage during Float operation	Minimum voltage available when no charger working and battery fully discharged upto 1.85V per cell.	Minimum Nos of cell
220 Volt	242 Volt	198 Volt	107
110 Volt	121 Volt	99 Volt	54
48 Volt	52.8 Volt	43.2 Volt	23

Bidder shall furnish calculation in support of battery sizing, selection of number of cells, float and Boost voltages during detailed engineering for Owners acceptance.
Battery sizing calculations shall be done as per IEEE- 485 on the basis of following duty cycle:

	Load	**Duration**	**Type Of Loads**
220V DC System	Continuous Load	3 hours	Relays, IEDs, Station HMIs, spring charging, Isolator interlocking load, Miscellaneous permanently connected loads etc.
	Emergency Load	1 hour	Substation emergency lighting loads.
	Momentary Load	1 minute	Breaker closing, Tripping loads (taking simultaneous occurrence as per system)
	Load	**Duration**	**Type Of Loads**
110V DC System	Continuous Load	3 hours	Relays, IEDs, Station HMIs, spring charging, Isolator interlocking load, Miscellaneous permanently connected loads etc.
	Emergency Load	1 hour	Substation emergency lighting loads.
	Momentary Load	1 minute	Breaker closing, Tripping loads (taking simultaneous occurrence as per system)
48V DC System	Continuous Load	3 hours	Continuous load associated with PLCs.(when speech is not working)
	Momentary Load	15 minute	Loads associated with PLCs (when speech is working)

1.2. Battery

1.2.1. Type

The DC Batteries shall be VRLA (Valve Regulated Lead-Acid) type and shall be Normal Discharge type. These shall be suitable for a long life under continuous float operations and occasional discharges. Air-conditioning shall be provided in Battery room the requirement of which has been specified elsewhere in the Technical Specification. The 220 V / 110V DC system is unearth and 48 V DC system is + ve earth system.

1.2.2. Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections.

1.2.3. Containers

The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28 %. The porosity of the container shall be such as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray.

1.2.4. Cell Covers

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

1.2.5. Separators

The separators used in manufacturing of battery cells, shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation and handling.

1.2.6. Pressure Regulation Valve

Each cell shall be provided with a pressure regulation valve. The valve shall be self re-sealable and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

1.2.7. Terminal Posts

Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

1.2.8. **Connectors, Nuts & Bolts, Heat Shrinkable Sleeves**

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge.
Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts and nuts can be used without lead coating.

All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

1.2.9. **Flame Arrestors**

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

1.2.10. **Battery Bank Stand**

All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

1.2.11. **Capacity Requirements**
When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27º Celsius) before any of the cells in the battery bank reaches 1.85V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 10 hrs up to 90% state of charge. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life.

The capacity (corrected at 27ºCelcius) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate:
(a) After Six minutes of discharge : 1.98V/cell
(b) After Six hours of discharge : 1.92V/cell

(c) After 8 hours of discharge : 1.85V/cell
(d) After 10 hours of discharge : 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35º Celsius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt hour efficiency shall be better than 80%.

1.2.12. **Expected Battery Life**

The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27º Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected life of 20 years at float operation.

1.2.13. **Routine Maintenance of Battery system**

For routine maintenance of battery system, the contractor shall supply 1 set of following tools:

a) Torque wrench.
b) Cell test voltmeter(-3-0-+3) volts with least count of 0.01Volt.

1.2.14. **Type Test of Battery**

1.2.14.1. Contractor shall submit type test reports of following tests as per IEC 60896-21 & IEC 60896-22, 2004. The type test reports shall be submitted in accordance with the requirements stipulated in clause no. 9.2 of Technical Specification, Chapter 2: GTR except that the requirement of tests having been conducted within last five years as mentioned therein shall not be applicable.

S.No.	Description of test
1.	Gas emission
2.	High current tolerance
3.	Short circuit current and d.c. internal resistance
4.	Protection against internal ignition from external spark sources
5.	Protection against ground short propensity
6.	Content & durability of required markings
7.	Material identification
8.	Valve operation
9.	Flammability rating of materials
10.	Intercell connector performance
11.	Discharge Capacity
12.	Charge retention during storage
13.	Float service with daily discharges for reliable mains power
14.	Recharge behaviour
15.	Service life at an operating temperature of 40^0 C for brief duration exposure time.

16.	Impact of a stress temperature of 60^0 C for brief duration exposure time with 3 h rate discharge test.
17.	Abusive over-discharge
18.	Thermal runaway sensitivity
19.	Low temperature sensitivity
20.	Dimensional sensitivity at elevated internal pressure and temperature
21.	Stability against mechanical abuse of units during installation

Tests shall be conducted in accordance with IEC 60896-21 & IEC 60896-22, 2004

1.2.14.2. **List of Factory & Site Tests for Battery**

Sl. No.	Test	Factory Tests	Site Tests
1.	Physical Verification		√
2.	C/10 Capacity test on the cell	√	
3.	8 Hrs. Charge and 15 minutes discharge test at full rated load		√

1.2.15. **Installation and commissioning**

1.2.15.1. Manufacturer of Battery shall supervise the installation and commissioning and perform commissioning tests as recommended in O&M manual / or relevant standards. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by Battery manufacturer/ Contractor

1.2.16. Contractor shall be submitted following documents for approval:

a) Data sheet as per Annexure-I
b) GA of cell and layout drawing
c) Discharge Data for 10 Hour, 8 Hour, 3 Hour, 2 Hour, 1 Hour, 15 Minutes and One Minute indicating capacity factors for end cell voltage of 1.75 V & 1.85 V.
d) Temperature correction factors
e) Installation and commissioning Instructions
f) O & M Manual

1.3. **Battery Charger**

The DC system for 220 V & 110V DC is unearthed and for 48 V DC is +ve earthed. The Battery Chargers as well as their automatic regulators shall be of static type and shall be compatible with offered VRLA batteries. All battery chargers shall be capable of continuous operation at the respective rated load in float charging mode, i.e. Float charging the associated Lead-Acid Batteries at 2.13 to 2.27 Volts per cell while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC Battery at 2.28 to 2.32 volts per cell at the desired rate.
Charger shall regulate the float/boost voltage in case of prescribed temperature rise of battery as per manufacturer's recommendation to avoid thermal runaway. Necessary temperature sensors shall be provided in mid location of

battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger.

1.3.1. All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during Float charging, the Charger output voltage shall remain within ±1% of the set value, for AC input voltage variation of ±10%, frequency variation of ±2.5%, a combined voltage and frequency variation of ±10%, and a DC load variation from zero to full load.

1.3.2. All battery chargers shall have a constant voltage characteristics throughout the range (from zero to full load) at the floating value of the voltage so as to keep the battery fully charged but without harmful overcharge.

1.3.3. All chargers shall have load limiters having drooping characteristic, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the Load limiter setting of the Charger. The Load-limiter characteristics shall be such that any sustained overload or short circuit in DC System shall not damage the Charger, nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short circuit.

1.3.4. Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load-limiter setting shall also be possible from 80% to 100% of the rated output current for Charging mode.

1.3.5. During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode.

1.3.6. The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage any where in the output range specified for Boost Charging mode.

1.3.7. The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode and the Load-limiter of Float charging mode is used as current setting device in boost charging mode.

1.3.8. Suitable filter circuits shall be provided in all the chargers to limit the ripple content (Peak to Peak) in the output voltage to 1%, irrespective of the DC load level, when they are not connected to a Battery.

1.3.9. **MCCB**

All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables from two sources. Mechanical interlock should be provided such that

only one shall be closed at a time. It shall be of P2 duty and suitable for continuous duty. MCCB's should have auxiliary contacts for annunciation.

1.3.10. **Rectifier Transformer**

The rectifier transformer shall be continuously rated, dry air cooled (A.N) and of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity.

1.3.11. **Rectifier Assembly**

The rectifier assembly shall be fully/half controlled bridge type and shall be designed to meet the duty as required by the respective Charger. The rectifier shall be provided with heat sink having their own heat dissipation arrangements with natural air cooling. Necessary surge protection devices and rectifier type fast acting HRC fuses shall be provided in each arm of the rectifier connections.

1.3.12. **Instruments**

One AC voltmeter and one AC ammeter alongwith selector switches shall be provided for all chargers. One DC voltmeter and DC ammeter (with shunt) shall be provided for all Chargers. The instruments shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 1.5 accuracy class. In addition to the above a centre zero voltmeter with selector switch shall also be provided for 220 V chargers for testing purpose.

1.3.13. **Air Break Switches**

One DC output switch shall be provided in all chargers. They shall be air break type suitable for 500 volts AC/ 250 DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be fully insulated from circuit. `ON' and `OFF' position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB's of suitable ratings shall also acceptable in place of Air Break Switch.

1.3.14. **Fuses**

All fuses shall be HRC Link type. Fuses shall be mounted on fuse carriers which are in turn mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type base. In such case one insulated fuse pulling handle shall be supplied for each charger. Fuse rating shall be chosen by the Bidder depending on the circuit requirement. All fuses in the chargers shall be monitored. Fuse failure annunciation shall be provided on the failure of any fuse.

1.3.15. **Blocking Diode**

Blocking diode shall be provided in the positive pole of the output circuit of each charger to prevent current flow from the DC Battery into the Charger.

1.3.16. **Annunciation System**

Audio-visual indications through bright LEDs shall be provided in all Chargers for the following abnormalities:

a) AC power failure
b) Rectifier/chargers fuse blown.
c) Over voltage across the battery when boost charging.
d) Abnormal voltage (High/Low)
e) Any other annunciation if required.

Potential free NO Contacts of above abnormal conditions shall also be provided for common remote indication "CHARGER TROUBLE" in Owner's Control Board. Indication for charger in float mode and boost mode through indication lamps shall be provided for chargers. A potential free contact for float/boost mode shall be provided for external interlocks.

1.3.17. **Name Plates and Marking**

The name plates shall be white with black engraved letters. On top of each Charger, on front as well as rear sides, larger and bold name plates shall be provided to identify the Charger. Name plates with full and clear inscriptions shall also be provided on and inside of the panels for identification of the various equipments and ease of operation and maintenance.

1.3.18. **Charger Construction**

The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalised and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger's internals. All the charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42 as per IEC:- 60947 Part 1.

1.3.18.1. All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger.

1.3.18.2. Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq.mm. stranded copper wires. Control terminals shall be suitable for connecting two wires, with 2.5 sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. Each wire shall bear a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits.

1.3.18.3. The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

1.3.19. **Painting**

All sheet steel work shall be pre-treated, in tanks, in accordance with IEC/International Standards. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be in accordance with IEC/International Standards. Welding shall not be done after phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade-692 (smoke grey) shall be applied, unless required otherwise by the Owner. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly staved. The paint thickness shall not be less than fifty (50) microns.

1.3.20. **TESTS**

1.3.20.1. Battery chargers shall conform to all type tests as per relevant International Standard. Performance test on the Chargers as per Specification shall also be carried out on each Charger as per specification. Rectifier transformer shall conform to all type tests specified in IEC: 60146 and short circuit test as per IEC:60076. Following type tests shall be carried out for compliance of specification requirements:

i) Voltage regulation test
ii) Load limiter characteristics test
iii) Efficiency tests
iv) High voltage tests
v) Temperature rise test
vi) Short circuit test at no load and full load at rated voltage for sustained short-circuit.
vii) Degree of protection test
viii) Measurement of ripple by oscilloscope.
ix) Temperature compensation feature demonstration

1.3.20.2. The Contractor may be required to demonstrate to the OWNER that the Chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before despatch as well as after installation at site. At site the following tests shall be carried out :

i) Insulation resistance test
ii) Checking of proper annunciation system operation.

1.3.20.3. If a Charger fails to meet the specified requirements, the Contractor shall replace the same with appropriate Charger without affecting the commissioning schedule of the Sub-station, and without any extra cost to the OWNER.

1.3.20.4. The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by the OWNER.

(i) Switches.
(ii) Relays/ MCCBs
(iii) Instruments.
(iv) DC fuses.
(v) SCR.

(vi) Diodes.
(vii) Condensers.
(viii) Potentiometers.
(ix) Semiconductor
(x) Annunciator.
(xi) Control wiring
(xii) Push buttons and contactors.

Makes of above equipment shall be subject to Owner's approval.

Annexure-I

BATTERY SYSTEM DATA SHEETS

S.No.	Description of Data	Unit	110 V	48 V
1	General Data			
a)	Battery Type:			
	Grid alloy: Pure lead(Pb), lead calcium (Pb-Ca),lead antimony (Pb-Sb), or lead selenium (Pb-Se) or other pl. specify			
	Cell type: Absorbed glass mat or gel cell or other please specify			
	Seller's type number			
	Number of positive plates per cell			
b)	Does each battery and battery [rack]/ [cabinet] meet the seismic requirements	[Yes] [No]		
c)	Manufacturer's Designed Life of Battery	Yrs		
d)	Recommended Battery Charger Data:			
	Floating voltage range	V		
	Boost charge	V		
	Current rating	Amps.		
	Recharge time	hr		
e)	Heat Released During:			
	Discharge duty cycle	Watt		
	Float charge	Watt		
	Boost Charge	Watt		
f)	Maximum Amount of Hydrogen Gas Evolved			
	During Battery-Boost Charge (2.33 V per cell) at Maximum Battery Temperature	(Litre /h)		
	Hydrogen Gas Evolution at Float	(Litre /h)		
g)	Time Battery may be Stored Without a Freshening Charge	months		
h)	Temperature Compensation Provided and its Details			

S.No.	Description of Data	Unit	110 V	48 V
2.	Physical Description.			
a)	Battery Cell:			
	Size (L x W x H)	mm		

	Weight	Kg				
	Volume of electrolyte gal	L				
	Jar cover material					
	Jar container material					
	Separator material					
	Retainer material					
	Limiting-oxygen index (LOI)					
b)	Battery [Rack] [Cabinet]:					
	Outline or catalog number					
	Quantity of [racks][cabinets] for the battery					
	Description (tier or step type)					
c)	Total Net Weight of Battery Including [Racks] [Cabinets]	kg				
d)	Total Shipping Weight of Each Battery Jar and Associated Equipment	kg				
e)	Connectors:					
	Intercell:					
	Type					
	Material					
	No. per connection					
	Inter-[Tier] [Step]:					
	Type					
	Material					
	No. per connection					
	Terminal Detail:					
	Type					
	Material					
f)	Terminal Lugs for Power Cable:					
g)	Torque Data:		**Initial Torque Value**	**Re-torque Value**	**Initial Torque Value**	**Re-torque Value**
	Intercell Connectors					
	Inter-[Tier] [Step]:					

S.No.	**Description of Data**	**Unit**	**110 V**	**48 V**
3.	Performance Data.			
	Battery String Designation No. [1] [ ]			
	Float Voltage Without Boost	V/cell		
	Float Voltage With Boost	V/cell		
	Boost Charge Voltage	V/cell		
	Recommended Frequency of Boost Charge			
	Recommended Duration of Boost			

	Charge			
	Open-Circuit Voltage	V/cell		
	Short-Circuit Current at Battery Terminals at Float Voltage at (27°C):			
	Battery Discharge Characteristics	A or A /positive plate		
	Guaranteed Amp-Hour Capacity (at the 10-hr rate) to Specified Final Voltage	AH		
	One-minute	A/cell		
	Fifteen-minute	A/cell		
	One-hour	A/cell		
	Two-hour	A/cell		
	Three-hour	A/cell		
	Eight-hour	A/cell		
	Ten-hour	A/cell		
4.	Required operating environment.			
	Battery Room Ambient Temperature Range	(°C to °C)		
	Battery Room Ambient Design Temperature	°C		
	Battery Room Minimum/Maximum Design Temperature	(°C to °C)		
	Maximum temperature at which battery can be stored	°C		

CHAPTER 6: LIGHTING SYSTEM

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1.0 LIGHTING SYSTEM

1.1 *LIGHTING SYSTEM FOR SUBSTATION*

The scope of work comprises of design, engineering, testing, supply, installation, testing and commissioning of various lighting fixtures complete with lamps, supports and accessories, ceiling fans complete with electronic regulators, exhaust fans for toilets and pantry & accessories, lighting panels, lighting poles complete with distribution boxes, galvanized rigid steel /rigid PVC conduits, lighting wires, G.I. Earthwire, receptacles, tag block & telephone socket, switchboards, switches, junction boxes, pull out boxes complete with accessories, for control room cum administrative building, Township, Indoor Switchgear room, Fire Fighting pump house, Switchyard and street lighting, GIS Building.

The entire control room building, fire fighting pump house,, Indoor Switchyard Building lighting shall be done by LED based low power consumption luminaries to achieve desired lux level specified. The bidder shall quote on lumpsum basis on the basis of design criteria specified for each control room building and fire fighting pump house.

1.1.1 SYSTEM DESCRIPTION

The lighting system shall comprise of the following:

1.1.2 AC Normal Lighting

AC lights will be connected to AC lighting panels. All the lights connected to the AC lighting system in different areas will be connected to the main lighting distribution boards.

1.1.3 AC Emergency Lighting

This system will be available in control room building, switchyard. AC lighting load will be connected to this system which will be normally ‘ON’. The lighting panels of this system will be connected to the Emergency lighting board which is fed from diesel generator during the emergency. 25% of lighting fixtures shall be connected on AC emergency lighting.

1.1.4 D.C. Emergency lighting

A few DC emergency lighting fixtures operated on the DC system will be provided in the strategic locations including staircase, corridors, electrical rooms, Battery charger room, LT switchgear room, GIS room, control room building that the operating personnel can safely find their way even during emergency of a total AC failure. These lights will be normally 'OFF' and will be switched 'ON'

automatically when under voltage occurs in the AC main lighting distribution board. GLS lamp down lighters in false ceiling area and Bulkhead fixtures in non false ceiling area to be used.

1.1.5 **Exit Lightings**

All Exit lightings in the buildings shall be fed by DC lighting panels. All necessary wiring and its termination shall be in the contractor's scope.

1.1.6 The lighting layout for and around Control Room Cum Administrative Office Building & Fire fighting Pump House indicating the type & BOQ for items shall be prepared and submitted by the contractor for owner's approval during detailed engineering.
The lux levels to be maintained in the switchyard shall be as per following:

Sl No	Area	Average Lux Level
1.	Control Room Building, Firefighting pump house, GIS Building and Indoor Switchyard Building	**SN. Area Average Lux level at floor level** i) Control Room & Conference room - 350 Lux ii) Battery room, Passage, Pantry, Toilets, Corridors etc. - 100 Lux iii) All other rooms and Buildings including township - 200 Lux
2.	Switchyard	-50 lux on main Equipments (i.e,Transformer, Reactor ISO, CB, CT, CVT, SA) at first level (Equipment connections level.) -20 lux on balance area of switchyard and street / Road at ground level. --10 lux (Area between fence and peripheral roads around the switchyard). The lighting between the fence and the peripheral road around switchyard shall be done by providing the lighting fixtures on lighting pole of suitable height, if required.

The minimum lux level to average lux level ratio should not be less than 0.6 (i.e Emin/Eav>0.6). The maintenance factor for indoor illumination design shall be considered as 0.8. The surface reflectance for ceiling/wall/floor shall be 50/30/10

For achieving the specified lux levels in the switchyard, the contractor can provide luminaries of 1x400 W/1x250 W and 2x400 W/ 2x250 W flood light as per requirement.

The contractor shall submit detailed calculation for reaching the above Lux level. Contractor shall conform the Lux levels at different locations of the switch yard and street lighting by measurement.

In addition to the normal lighting provided in the switchyard area to maintain the desired lux levels, high beam fixtures(Type SF4- 8 nos) on swivel support shall be provided in strategic locations near equipments for new substations which shall be kept normally OFF and these shall be switched ON in case of maintenance work.

1.1.7 Ceiling fans (1400 mm sweep, AC 230 volts) shall be provided in, fire fighting pump house and non AC rooms in the control room building and township buildings as per the requirements. Wall mounted fans shall be provided in the conference room, control room, shift manager and substation incharge rooms in control room building. Exhaust fans shall be provided in toilets and pantry.

1.1.8 One no. of aluminum ladder of each size shall be supplied by the contractor for maintenance purpose.

1.1.9 The following specific areas are included in the scope of lighting:

(i) Switchyard Area.
(ii) Switchyard Control Room cum Administrative Office Building
(iii) Fire fighting pump house
(iv) Street lighting (peripheral) inside switchyard fencing (Street lighting shall be done using street lighting poles)
v) DG area lighting
vi) LT Transformer area
vii) GIS Building and Indoor Switchyard Building
viii) Township

1.1.10 **For Outdoor Illumination**

The switchyard and street lighting design including lux level calculations, surface illuminance diagram at varying equipment surface levels , detailed drawings showing the lighting layout and Electrical distribution diagram and BOQ for items shall be prepared by the Contractor and submitted for approval. The above layout drawings will include disposition and location of lighting fixtures, receptacles, etc.

1.1.11 **For Indoor Illumination**

The conduit layout drawing for substation buildings, Electrical distribution diagram for substation buildings, & for substation yard etc. shall be prepared by the Contractor. All wiring including telephone wiring (tinned two pair copper) shall be in concealed conduit. Concealed MS junction boxes for sockets and light points shall be provided in all the rooms of Control Room cum Administrative Office Building and Fire Fighting pump house. In case where

false ceiling surface conducting is permissible, all down run conduits will be concealed in wall below the false ceiling.

1.1.12 Each cable run shall be tagged with number that appear in the cable schedules. Cables shall be tagged at their entrance and/or exit from any piece of equipment, junction or pull box, floor opening etc.

1.1.13 The tag shall be made up of aluminum with the number punched on it and securely attached to the cable by not less than two turns of G.I. wire. Cable tags shall be rectangular in shape for power cables and circular shape for control cables.

1.1.14 Location of cables laid directly under ground shall be indicated clearly by cable marker made of galvanised iron plate embedded in concrete block.

1.1.15 The location of under ground cable joints if any, shall be clearly indicated with cable marker with an additional inscription "cable joint".

1.1.16 The marker, which is a concrete block, shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change of direction. It shall also be located on both sides of the road or drain crossing.

1.2 LIGHTING SYSTEM FOR TOWNSHIP

1.2.1 The scope of work comprises of design, engineering, testing, supply, installation, testing and commissioning of 400 V, 400Amp, Main Township Distribution board/Energy meter Boards/Flat DBs etc., Power and Control cables, various lighting fixtures complete with lamps, supports and accessories, ceiling fans complete with electronic regulators, exhaust fans for toilets and pantry & accessories, lighting panels, lighting poles complete with distribution boxes, galvanized rigid steel/PVC conduits, lighting wires, G.I. Earthwire, receptacles, tag block & telephone socket, bells, boxes for telephone/television & Air-conditioners points, switchboards, switches, junction boxes, pull out boxes complete with accessories for various type of quarters, parking, pump house, recreation centre and transit camp associated with township.

The township lighting design including lux level calculations, surface illuminance diagram at varying equipment surface levels , detailed drawings showing the lighting layout and Electrical distribution diagram and BOQ for items shall be prepared by the Contractor and submitted for approval. The above layout drawings will include disposition and location of lighting fixtures, receptacles, etc.

1.2.2 SYSTEM DESCRIPTION

The township lighting system shall comprise of the following:

1.2.3 EXTERNAL ELECTRIFICATION WORKS

The entire External Electrification work including connection to various quarters, recreation centres & transit camp associated with township including street lighting of township shall be in the scope of the contractor. 400V,400A, Main Township distribution board shall be fed from 400V, Main switchboard (being supplied under LT switchgear package) through 2-3 ½ x300 sqmm XLPE insulated power cable from each source. Supply of Main Township DB & associated 3 ½ x300 sqmm XLPE cable along with its interconnection, installation etc shall be in the scope of contractor.

The entire external electrification work comprising of feeder pillars, Cables and associated glands and lugs, steel tubular poles, street lights, MS junction boxes, GI pipes for cable protection, danger plates, Hume pipes, fire extinguishers, cable route markers etc as required shall be in the scope of the contractor

1.2.4 INTERNAL ELECTRIFICATION WORKS

The scope shall broadly consist of entire concealed conduit work, wiring for lights/power/fans/telephones/cables & air-conditioners, supply and fixing of metal boxes, plates, switches, sockets, call bells, buzzers, exhaust fans, ceiling fans, MCBs, MCCBs, light fittings, energy meters boards & flat DBs etc as per the requirements of various quarters, recreation centres and transit camps.

In addition to above complete earthing (through separate earth pit) and lightning protection for each type of quarters ,recreation centre and transit camp shall be provided as per standard guidelines given in relevant Indian standards and code of practices. The complete drawing for earthing and lightning protection shall be submitted to owner for approval. The loop earthing inside the buildings shall be carried out with minimum 1Cx1.5 sqmm PVC stranded Copper wire . All materials required or earthing and lightning protection of township buildings shall be in the scope of contractor.

2.0 DESCRIPTION OF ITEMS

2.1 *DESCRIPTION OF ITEMS FOR SUBSTATION LIGHTING*

The Contractor shall supply and install the following equipment and accessories in accordance with the specification.

2.1.1 LIGHTING PANELS

2.1.1.1 OUTDOOR

400 AC lighting panel with 400V, 63A, 3 phase 4 wire bus and one no. 63A, TPN, MCB with neutral unit as incomer and 20A, SP MCB as outgoing feeders, the details are as follows.

Type Of Panel	Description	Detail Of Outgoing Feeders
ACP 2	Outdoor	6 nos- 20 A single pole MCB and 3 No. 32 A Triple pole MCB with Neutral and suitable timer and contactor for automatic switching.
ACP 3	Outdoor Street lighting Panel	3 nos.-32A Triple pole MCB with Neutral with suitable timer and contactor for automatic switching

Note: The number of outgoing feeders indicated above are the minimum.

2.1.1.2 INDOOR

400 V indoor AC lighting panel ,63 A 3 phase 4 wire bus and one number 63 amp FP MCB with 300ma 63 A FP RCCB. Flush mounted with per phase isolation and LED indication lamps. The DB will be flush mounted and double door type.

Type Of Panel	Description	Detail Of Outgoing Feeders
ACP 1	Indoor	18 nos outgoing ,16 Amps SP MCB

220V DC indoor type change over board and 220V DC 32A two wire bus and one 32A contractor backed up by 32A double pole MCB as incomer. The panel shall have local push button controls. Following are the various types of panels required with control timer.

Type Of Panel	Description	Detail Of Outgoing Feeders
DCP	Indoor	6 nos outgoing ,16 Amps DP MCB

2.1.1.3 Sub-Lighting Panels

Type Of Panel	Description	Detail Of Outgoing Feeders
SLP	Outdoor	4 pole 32A Isolator suitable for 400V, 50 cycles AC supply, wlith LILO

		facility using 8 nos terminal blocks suitable for cable upto 16 mm sq cable Enclosure shall be suitable for outdoor use with IP-55 degree of protection as per IEC:60529.

2.1.2 **Lighting Fixtures**

Please Refer Annexure-1

2.1.3 **RECEPTACLES**

	Description	Detail Of Outgoing Feeders
RO	Outdoor	15A, 230V, Receptacle 2 pole, 3- pin type
RP	Outdoor	63A, 400V, Interlocked switch socket, receptacle
RI	Indoor	5/15A, 230V, Receptacle 3-pin type (Modular)

2.1.4 (a) **SWITCH BOARDS**

Modular type switches, 5/15 Amp. Receptacles.

2.1.4 (b) **CONDUITS AND ACCESSORIES**

Galvanised Rigid steel or Rigid PVC conduits of 20/25 /32 mm for Lighting and Telephone wiring

2.1.5 **JUNCTION BOXES -** with 5 Nos. of terminal blocks

2.1.6 **LIGHTING POLES -** (Type A1 poles & Type E1 poles)

2.1.7 **FANS-**1400 mm Sweep with Electronic regulator and 450 mm Wall Mounted fans

2.1.8 **MAINTENANCE EQUIPMENT**

i) A type Aluminium ladder of 3 mtr vertical height.

ii) Cartwheel mounted aluminium ladder Vertical Extendable from 5.1m to 11m.

2.1.9. **RECEPTACLES**

a) All receptacles shall be of cast steel/aluminium, heavy duty type, suitable for fixing on wall/column and complete with individual switch.

b) In general the receptacles to be installed are of the following types:

i) **Type RO**-15A, 230V, 2 pole, 3 pin type with third pin grounded, metal clad with gasket having cable gland entry suitable for 2Cx6 sq.mm. PVC/aluminum armoured cable and a metallic cover tied to it with a metallic chain and suitable for installation in moist location and or outdoor. The switch shall be of rotary type. Receptacles shall be housed in an enclosure made out of 2 mm thick Gl sheet with hinged doors with padlocking arrangements. Door shall be lined with good quality gasketing. This shall conform to IP-55.

ii) **Type RI-**The 5/15 amp 6 pin receptacles with switches will be of Modular type with flush type switches and electroplated metal enclosures of approved make

iii) **Type RP** - 63A, 400V, 3 phase, 4 pin interlocked plug and switch with earthing contacts. Other requirements shall be same as type RO. The receptacle shall be suitable for 3.5C x 35/3.5Cx70 sq.mm. aluminium conductor cable entry and shall also be suitable for loop-in and loop out connection of cables of identical size. Receptacle shall be suitable for outdoor application. Receptacles shall be housed in a box made out of 2mm thick G.I. sheet, with hinged door with padlocking arrangement. Door shall be lined with good quality gasketing. This shall conform to IP-55.

2.1.10. LIGHTING PANELS (L.P.)

2.1.10.1 Each panel shall be provided with one incoming triple pole MCB with neutral link and outgoing miniature circuit breakers as per clause 2.0. The panels shall conform to IEC: 60439.

2.1.10.2 Constructional Features

a) Panels shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be of thickness not less than 2.00 mm (cold rolled) smoothly finished, levelled and free from flaws. Stiffners shall be provided wherever necessary. The indoor lighting panels will be ready made DB of minimum 1.6 mm sheet thickness.

b) The panels shall be of single front construction, front hinged and front connected, suitable for either floor mounting on channels, sills or on walls/columns by

suitable M.S. brackets. Indoor panels in control room shall be flush mounted.

c) Panels shall have a dead front assembly provided with hinged door(s) and out door panels will be with padlocking arrangement with single key supplied in duplicate.

d) All out door panels, removable covers, doors and plates shall be gasket all around with neoprene gaskets.

e) The outdoor panels shall be suitable for cable/conduit entry from the top and bottom. Suitable removable cable gland-plate shall be provided on the top and bottom of panels. Necessary number of double compression cable gland shall be supplied, fitted on to this gland plate. The glands shall be screwed on top and made of tinned brass.

f) The panels shall be so constructed as to permit free access to connection of terminals and easy replacement of parts.

g) Each panel shall have a caution notice fixed on it.

h) Each panel will be provided with directory holder in which printed and laminated as built circuit directory would be kept inside a document holder/pasted at site.

i) Each Outdoor lighting panel shall be provided with one no. 'ON' indicating lamp for each phase alongwith fuses. For indoor lighting panels din mounted phase indication lamps will be provided, mounted along side of the MCB

j) **Main Bus Bars**

Bus bars shall be of aluminium alloy conforming to IEC: 60114/60105 and shall have adequate cross-section to carry the rated continuous and withstand short circuit currents. Maximum operating temperature of the bus bars shall not exceed 85 deg. C. The bus bars shall be able to withstand a fault level of 9 kA for 1 sec. for AC panels and 4 KA for 1 sec. for DC panels. The Indoor lighting panels shall have copper bus bar

2.1.10.3 **JUNCTION BOXES**

a) The junction boxes shall be concealed type for indoor lighting and suitable for mounting on columns, lighting poles, structures etc., for outdoor lighting.

b) Junction boxes shall be of square/rectangular type of 1.6 mm sheet steel with minimum 6 mm thick pressure diecast aluminium material LM-6 and shall have bolted cover with good quality gasket lining.

c) The junction box and cover of sheet steel construction shall be hot dip galvanised.

d) The junction boxes shall be complete with conduit knockouts/threaded nuts and provided with terminal strips .The junction boxes shall be suitable for termination of Cable glands of dia 20 mm, 25 mm, 32 mm, 40 mm on all sides. The junction boxes shall be provided with 4 way terminals suitable for two numbers 10 sq. mm. wire & for street lighting/switchyard lighting suitable for 2 numbers 4C x 16 Sq.mm Al. cable.

e) The junction boxes shall have the following indelible markings

(i) Circuit Nos. on the top.
(ii) Circuit Nos. with ferrules (inside) as per drawings.
(iii) DANGER sign in case of 400 volt junction box.

f) The junction boxes shall be weather proof type with gaskets conforming to IP 55 as per IEC: 60529.

2.1.10.4 **Occupancy Sensors:**

Sufficient number of occupancy sensors shall be provided in the stairs area and corridors of control room cum administrative building and GIS Building. Each occupancy sensor shall be used for indoor use with time delay programmable in the minimum range of 1 sec. to 2 Hour to control the illumination in the area.

2.2 DESCRIPTION OF FCOMMON ITEMS FOR LIGHTING

2.2.1 LIGHTING FIXTURES AND ACCESSORIES

2.2.1.1 General

All lighting fixtures and accessories shall be designed for continuous operation under atmospheric conditions existing at site, without reduction in the life or without any deterioration of materials, internal wiring.

2.2.1.2 Temperature Rise

All lighting fixtures and accessories shall be designed to have a low temperature rise according to the relevant International standard. The design ambient temperature shall be taken as 50 deg.C.

2.2.1.3 Supply Voltage

Lighting fixtures and accessories meant for 230V A.C. operation shall be suitable for operation on 230V A.C. 50Hz, supply voltage variation of ± 10%, frequency variation of ± 2.5% and combined voltage and frequency variation of ± 10%.

Lighting fixture and accessories meant for 220V DC operation shall be suitable for operation on 220V DC with variation between 190 to 230 Volts.

2.2.1.4 **Lighting Fixtures**

a) The lighting fixtures shall be Philips or equivalent International make except for fixtures type 'DSM' & 'HL' for which make has been specified elsewhere in this chapter. The different types of lighting fixtures are also indicated elsewhere in this Chapter.

b) All fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.

c) All lighting fixtures shall be complete with fluorescent tubes / incandesent lamps/mercury vapour/sodium vapour lamps as specified and shall be suitably wired up.

d) All flourescent lamp fixture shall be complete with all accessories like ballasts, power factor improvement capacitors, lamps, starters, holders etc.

e) High beam fixtures shall be suitable for pendant mounting and flood lights shall have suitable base plate / frame for mounting on steel structural member. Hook mounted high beam fixtures are not acceptable.

f) Each lighting fixture shall be provided with an earthing terminal suitable for connection to 16 SWG GI earthing conductors.

g) All light reflecting surfaces shall have optimum light reflecting co-efficient such as to ensure the overall light output as specified by the manufacturer.

h) Height of fixtures should be such that it is easy to replace the lamps with normal ladder/stool. In case the ceiling height is very high, the fixtures may be placed on the walls for ground lighting.

2.2.1.5 **ACCESSORIES**

2.2.1.5.1 **Lamp holders and Starter Holders**

(a) Lamp holders/starter holders for fluorescent tubes shall be of the spring loaded, low contact resistance, bi-pin rotor type, resistant to wear and suitable for operation at the specified temperature, without deterioration in insulation value, contact resistance or retention of the lamp/starter. They shall hold the lamp/starter in position under normal condition of shock and vibration.

(b) Lamp holders/starter for incandescent lamps and HPMV/HPSV lamps shall be of screwed type, manufactured in accordance with relevant standard and designed to give long and satisfactory service.

2.2.1.5.2 **Ballasts**

a) All HPSV/HPMV/Metal halide lamp fixtures shall be provided with wire wound ballasts. All fluorescent fixtures shall be provided with high frequency electronic ballasts. The Ballasts shall be designed, manufactured and supplied in accordance with relevant standard and function satisfactorily under site condition specified. The ballasts shall be designed to have a long service life and low power loss.

b) Ballasts shall be mounted using self locking anti-vibration fixing and shall be easy to remove without dismantling the fixtures. They shall be totally enclosed units.

c) The wire-wound ballasts shall be of the inductive, heavy duty type, filled with thermosetting insulating moisture repellent polyester compound filled under pressure or vacuum. The ballast wiring shall be of copper wire. They shall be free from hum. Ballasts which produce humming sound shall be replaced free of cost by the Contractor. Ballasts for high pressure mercury vapour/ HPSV lamps shall be provided with suitable tappings to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure.

d) Separate ballast for each lamp shall be provided in case of multi-lamp fixtures.

e) High frequency electronic ballasts shall be capable of satisfactory performance in adverse environment like that of EHV substation. Ballasts shall consist of AC/DC converter, high frequency power oscillator and low pass filter. The ballasts shall be suitable for use of nominal voltage of 230V +/- 10%, 50 Hz supply. The filter circuit shall suppress the feedback of high frequency signals to the mains. The ballast shall be rated for 36/40W fluorescent fixtures. The ballasts shall confirm to IEC 68-2-6FC, IEC 60929 for performance, IEC 60928 for safety and EN 55015, EN 55022A for RFI and EN 61003.

2.2.1.5.3 **Capacitors**

a) The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

b) Power factor of fluorescent lamp fixtures with HF electronic ballast shall not be less than 0.90 and that of High pressure Sodium Vapour, Mercury

Vapour and Metal Halide lamp fixtures shall not be less than 0.85. The capacitors shall be suitable for operation at supply voltage as specified and shall have a value of capacitance so as to correct the power factors of its corresponding lamp circuit to the extent of 0.98 lag.

c) The capacitors shall be hermetically sealed in a metal enclosure.

2.2.1.5.4 **Lamps**

a) General Lighting Services (GLS) lamps shall be provided with screwed caps and shall be of 'clear' type unless otherwise specified.

b) The Bidder shall furnish typical wiring diagram for Fluorescent, HPMV & HPSV fitting including all accessories. The diagram shall include technical details of accessories i.e. starters, chokes, capacitors etc.

c) Flexible conduits if required, for any fixture shall be deemed to be included in Contractor's scope.

2.2.1.5.5 **SWITCH AND SWITCHBOARD**

(a) All Switch board/boxes, 5/15 Amp Receptacles and electronic fan regulators located in office/building areas shall be modular flush mounted type or brick wall with only the switch knob projecting outside.

(b) Switch boards/boxes shall have conduit knock outs on all the sides.

(c) The exact number of switches including regulator for fans and layout of the same in the switchboard shall be to suit the requirement during installation.

(d) The maximum number of luminaires, controlled by one no 6 amp switch would 4 nos. For DC fixtures there will be no switch and the same shall be directly controlled from DC LP

(e) The luminaires shall be wired in such a fashion that luminaires on each phase are evenly distributed all over the room.

2.2.1.5.6. **CONDUITS & CONDUIT ACCESSORIES**

a) The conduits shall conform to IEC: 61386 or IEC: 61035 or IEC: 60614 as applicable. All steel conduits shall be seemed by welding, shall be of heavy gauge and shall be hot dip galvanised.

b) Flexible conduits wherever required shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips or PVC/Plastic.

c) All conduits accessories shall conform to relevant IEC and shall be hot dip galvanized or High quality virgin PVC.

2.2.1.5.7 **TERMINAL BLOCKS**

Each terminal shall be suitable for terminating upto 2 Nos. 10 sq.mm. stranded Aluminium Conductors without any damage to the conductors or any looseness of connections. Terminal strips provided in street - lighting poles shall be suitable for terminating upto 2 nos. 4C x 16 sq. mm aluminium cables.

2.2.1.5.8 **PULL OUT BOXES**

a) The pull out boxes shall be concealed type for indoor lighting and suitable for mounting on column, structures etc., for outdoor lighting. The supply of bolts, nuts and screws required for the erection shall be included in the installation rates.

b) The pull out boxes shall be circular of cast iron or 16 SWG sheet steel and shall have cover with good quality gasket lining.

c) The pull out boxes and cover shall be hot dip galvanised.

d) The pull out boxes shall be completed with conduit knock outs/threaded hubs and provided at approximately 3 meters intervals in a conduit run.

2.2.1.5.9 **Residual Current Circuit Breakers (RCCB)**

For indoor panels 63A 4pole 300 ma RCCB conforming IEC 13947 will be provided along with incomer.

2.2.1.5.10 **Miniature Circuit Breaker (MCB)**

a) The miniature circuit breakers shall be suitable for manual closing, opening, automatic tripping under overload and short circuit. The MCBs shall also be trip free. MCB of Type C tripping characteristics as per IEC: 60898 will be used for Switchyard lighting.

b) Single pole as well as three pole versions shall be furnished as required in the Schedule of Lighting Panels.

c) The MCBs and panel MCCB together shall be rated for full fault level. In case the MCB rating is less than the specified fault level the bidder shall co-ordinate these breaker characteristics with the back up MCCB in such a way that if fault current is higher than breaker rating, the MCCB should blow earlier than the breaker. If the fault current is less than MCB breaking capacity, MCB shall operate first and not the incomer MCCB.

d) The MCBs shall be suitable for housing in the lighting panels and shall be suitable for connection with stranded copper wire connection at both the incoming and outgoing side by copper lugs or for bus bar connection on the incoming side.

e) The terminals of the MCBs and the 'open' 'close' and 'trip' conditions shall be clearly and indelibly marked.

f) The tenderer shall check and co-ordinate the ratings of MCBs with respect to starting characteristics of discharge lamps. The vendor has to furnish overload and short circuit curve of MCB as well as starting characteristics curves of lamps for Employer's approval.

g) The MCB shall generally conform to IEC: 60898.

2.2.1.5.11 **Contactors**

Contactors shall be of the full voltage, direct-on line air break, single throw, electro-magnetic type. They shall be provided with atleast 2-'NC' and 2'NO' auxiliary contacts. Contactor shall be provided with the three element, positive acting, ambient temperature compensated time lagged, hand reset type thermal overload relay with adjustable settings to suit the rated current. Hand reset button shall be flush with the front of the cabinet and suitable for resetting with starter compartment door closed. The Contactor shall be suitable for switching on Tungsten filament lamp also. The bidder shall check the adequacy of the Contactors rating wire with respect to lighting load.

2.2.1.5.12 **Push Buttons**

All push buttons shall be of push to actuate type having 2 'NO' and 2 'NC' self reset contacts. They shall be provided with integral escutcheon plates engraved with their functions. Push buttons shall be of reputed make.

2.2.1.5.13 **Labels**

a) The lighting panels shall be provided on the front with panel designation labels on a 3 mm thick plastic plate of approved type. The letter shall be black engraved on white back ground.

b) All incoming and outgoing circuits shall be provided with labels. Labels shall be made of non-rusting metal or 3 ply lamicold. Labels shall have white letters on black or dark blue background.

2.2.1.5.14 **Earthing Terminals**

Panels shall be provided with two separate and distinct earthing terminals suitable to receive the earthing conductors of size 50x6 G.S. Flat.

2.2.1.5.15 Type test reports for following tests on all lighting panels shall be submitted for approval as per clause 9.2 of Chapter 2: GTR.

(i) Wiring continuity test
(ii) High voltage (2.5 KV for 1 minute) and insulation test
(iii) Operational test
(iv) Degree of protection (not less than IP-55 test on outdoor Lighting Panels and IP-52 test on indoor Lighting Panels as per IEC: 60947 (part 1)
(v) Heat run test

2.2.1.5.16. **LIGHTING POLES**

a) The Contractor shall supply, store and install the following types of steel tubular lighting poles required for street lighting.

i) Type A1 Street Lighting Pole - for one fixture
ii) Type E1 Post top lantern pole - for one fixture

b) Street/flood light poles shall conform to the enclosed drawings. In front of control room building, and Fire Fighting Buildings, decorative post top lantern (Type E1) poles and Bollards shall be installed.

c) Lighting poles shall be complete with fixing brackets and junction boxes. Junction boxes should be mounted one meter above ground level.

d) The lighting poles shall be coated with bituminous preservating paint on the inside as well as on the embedded outside surface. Exposed outside surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium).

e) The galvanised sheet steel junction box for the street lighting poles shall be completely weather proof conforming to IP-55 and provided with a lockable door and HRC fuse mounted on a fuse carrier and fuse base assembly. The fuses & junction box shall be as specified in the specification. However, terminals shall be stud type and suitable for 2 nos. 16 sq.mm. cable.

f) Wiring from junction box at the bottom of the pole to the fixture at the top of the pole shall be done through 2.5 sq. mm wire.

g) Distance of centre of pole from street edge should be approximately 1000 to 1200 mm.

h) Earthing of the poles should be connected to the switchyard main earth mat wherever it is available and the same should be earthed through 3M long, 20 mm dia, earth electrode.

2.2.1.5.17 CEILING & WALL MOUNTED FANS AND REGULATORS

a) The contractor shall supply and install 1400 mm sweep ceiling fans complete with electronic regulator and switch, suspension rod, canopy and accessories. The wall mounted fans shall be of 400 mm sweep

b) The contractor shall supply and install the switch, electronic regulator and board for mounting switch and electronic regulator for celling fans. The regulator will be housed in common switchboard for lighting and shall be of similar make and model as that of modular switches.

c) Winding of the fans and regulators shall be insulated with Class-E insulating material. Winding shall be of copper wire.

d) Electronic regulator with stepped control shall be provided.

2.2.1.5.18 LIGHTING WIRES

a) The wiring used for lighting shall be standard products of reputed manufacturers.

b) The wires shall be of 1100 V grade, PVC insulated product of reputed manufacturers.

c) The conductor sizes for wires used for point wiring beyond lighting panels shall be 2.5 sq.mm, 4 sq.mm, 6 sq.mm and 1.5 sq.mm stranded copper wire.

d) The wires used for connection of a lighting fixture from a nearest junction box or for loop-in loop-out connection between two fluorescent fixtures shall be single core copper stranded conductor, 1100V grade flexible PVC insulated cords, unsheathed, conforming to IEC:60502 with nominal conductor cross sectional areas of 2.5 sq. mm.

e) The wires shall be colour coded as follows:

Red for R - Phase
Yellow for Y - Phase
Blue for B - Phase
Black for Neutral
White for DC (Positive)
Grey for DC (Negative)

2.2.1.5.19 LIGHTING SYSTEM INSTALLATION WORKS

2.2.1.5.19.1 General

In accordance with the specified installation instructions as shown on manufacturer's drawings or as directed by Employer, Contractor shall unload, erect, install, test and put into commercial use all the electrical equipment included in the contract. Equipment shall be installed in a neat, workmanship manner so that it is level, plumb square and properly aligned and oriented. Tolerances shall be as established in manufacturers drawing or as stipulated by Purchaser.

All apparatus, connections and cabling shall be designed so as to minimize risk of fire or any damage which will be caused in the event of fire.

2.3.1.5.19.2 Conduit System

a) Contractor shall supply, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes (as specified in specification ordinary and inspection tees and elbow, checknuts, male and female bushings (brass or galvanised steel), caps, square headed make plugs, nipples, gland sealing fittings, pull boxes, conduits terminal boxes, glands, gaskets and box covers, saddle terminal boxes, and all steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits. The contractor shall also supply 20 mm PVC conduit and accessories for telephone wiring.

b) All unarmoured cables/wires shall run within the conduits from lighting panels to lighting fixtures, receptacles. etc.

c) Size of conduit shall be suitably selected by the Contractor.

d) Conduit support shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

e) Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonary or concrete for conduit support is not acceptable.

f) Where conduits are along with cable trays they shall be clamped to supporting steel at an interval of 600 mm.

g) For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to

support the conduit rigidly and to hold it in place.

h) For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.

i) Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

j) Conduits joints and connections shall be made through water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.

k) The entire metallic/PVC conduit system, shall be embedded, electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.

l) Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduit ends shall be plugged or capped to prevent entry of foreign material.

2.2.1.5.19.3 **Wiring**

a) Wiring shall be generally carried out by PVC insulated wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawings of wires is permissible.

b) Wires shall not be pulled through more than two equivalent 90 deg. bends in a single conduit run. Where required, suitable junction boxes shall be used.

c) Wiring shall be spliced only at junction boxes with approved type terminal strip.

d) For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.

e) For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/junction box.

f) Maximum two wires can be terminated to each way of terminal connections.

g) Separate neutral wires are to be provided for each circuit.

h) AC and DC wiring should not run through the same conduit.

2.2.1.5.19.4 Lighting Panels

a) The lighting panels shall be erected at the locations to be finalised during detailed engineering.

b) Suitable foundations/supporting structures for all outdoor type lighting panels shall be provided by the Contractor.

2.2.1.5.19.5 Foundation & civil works

a) Foundation for street lighting poles, panel foundation and transformer foundation shall be done by the Contractor. The payment towards execution, PCC & RCC shall be made under relevant items of civil work mentioned in Bid Price schedule.

b) All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grouting of anchor bolts, sills, inserts and flastening devices shall be carried out by the Contractor including minor modification of civil works as may be required for erection.

c) Any cutting of masonary / concrete work, which is necessary shall be done by the Contractor at his own cost and shall be made good to match the original work.

ANNEXURE-1

SI. No.	Type of Lighting Fixture	Description	Philips Catalogue No
1	F1	2x28W T5 type fluorescent lamps in industrial reflector type fixture, complete with accessories and suitable for pendent /surface mounting.	TMS 122/228 HF
2	FF	2x28 T5 energy efficient fluorescent lamps with low glare, mirror optics suitable for recess mounting type lighting fixture.	TBS 088/228 C5 HF
3	FL	2x28W T5 energy efficient fluorescent lamps with low glare mirror optics suitable for pendent/surface mounting with all accessories	TCS 398/228 D6 HF
4	TL	Sleek and Functional electronic decobatten suitable for use with 1x'TLD'36W fluorescent lamp with dual tone end caps. Pre-phosphated & powder coated CRCA steel channel complete with all electrical accessories like electronic ballast, lamp holders all prewired up to a terminal block	TMS500/136 HF
5	IB	60/100w GLS lamp in Bulkhead fixtures with Cast Aluminium alloy body, suitable for column, wall,and ceiling mounting finished stove enameled silver grey outside	NXC101
6	BL	Aesthetic wall/ceiling mounted luminaire suitable for 1x PL-C 13W OR 11W CFL. Low loss O.C. Copper ballast.Built in high gloss anodized reflector. Twin finish UV stabilised SAN diffuser for protection & elimination of lamp glare.	FMC21/113
7	SL	Aesthetic ceiling mounted luminaire for Ecotone crystal/Décor CFL of 2x9W or 1x18W. ABS housing pre-wired with porcelain lampholder. Pre-phospated plated CRCA gear tray.	FL343/118
8	BH	Bulkhead luminaire suitable for use with PL-S 9W CFL. Single piece pressure die-cast aluminium & cover retaining Frame. Opal acrylic cover along with a gasket made of E.P.R..	FXC 101/109
9	BLD	2X9 Or 1x18 watt CFL bollard light for landscape lighting having FRP/LLDPE housing	FGC202 /118
10	DLR	2x18 watt CFL Downlighter with HF ballast suitable for recess mounting	FBH145/218L HF
11	DSM	1X13 WATT surface mounted CFL	FCS100/113
12	IF	Incandescent GLS lamp down light	DN622

13	SF1	1 X 400W HPSV lamps in high flood lighting fixture with integral control gear	SWF 330/1X400
14	SF2	2 X 400W HP sodium Vapour lamps in high flood lighting, non-integral control gear:	RVP302/2x400W
15	SF3	1 X 250W HPSV lamps in high flood lighting fixture with integral control gear:	SWF 330/1X250
16	SF4	150W HP Metal halide MHN-TD lamp in flood lighting fixture with integral control gear.	SWF230/150 MHN-TD
17	SF5	125 HP MV Lamp in weather proof post top lantern for mounting on pole top	HPC-101/125 HPF
18	SC	150W SON-T Tubular Sodium Vapour lamp in street lighting	SRX-51/150

CHAPTER-7: LT TRANSFORMER

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CHAPTER 7: LT TRANSFORMER

1.0 INTENT

This specification is intended to cover outdoor type oil filled 315 kVA, 11/0.400kV, transformers .

2.0 SCOPE OF WORK

2.1 Scope of Supply

- Transformers as listed above, with insulating oil, all materials and accessories, and complete in all respects.
- Gland plates, power cable, lugs, anchor bolts and hardwares.
- Mandatory & optional spares and special maintenance equipments if any.

2.2 Scope of Service

The scope includes but is not limited to the following items of work to be performed for all equipment and materials furnished under this chapter:

a) Design, manufacturing, shop testing, packing & despatch

b) Transportation inclusive of insurance and delivery, FOR site basis

c) Unloading, handling, storing, transportation at site up to foundations, oil filling and treatment, erection, testing and commissioning

d) Civil Works

e) Supply of external cables and termination as required.

f) Fire protection system.

3.0 General Information

3.1 All temperature indicators, Buchholz relays and other auxiliary devices shall be suitable for 110 V DC Control supply. All alarm and trip Contacts shall also be suitable for connection in 110 V DC Circuits.

3.2 Bidders may specifically note that transformers offered shall conform to dynamic short circuit test and dielectric test as per IEC: 60076. Test report for the same shall be submitted during detail engineering for approval.

4.0 TECHNICAL REQUIREMENTS

4.1 Core

The core shall be constructed from high grade, non-aging, cold rolled grain-oriented silicon steel laminations. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density at any tap position with 10% voltage variation from the voltage corresponding to the tap shall not exceed 1.9 Wb/sq-m.

4.2 Windings

The conductor shall be of electrolytic copper, free from scales and burrs.

4.3 Insulating Oil

The oil supplied with transformer shall be unused and have the parameters for unused new oil conforming to IEC: 60296 while tested at oil Contractor's premises, No inhibitors shall be used in oil. Ten percent extra oil shall be supplied for topping up after commissioning in nonreturnable containers suitable for outdoor storage.

4.4 Terminal Arrangement

a) Bushing terminals shall be provided with suitable terminal connectors of approved type and size for cable/overhead conductors' termination of HV side and cable termination on LV side.

b) The neutral terminals of 400V winding shall be brought out on a bushing along with the 433 volt phase terminals to form a 4 wire system for the 400 volt. Additional neutral bushing shall also be provided for earthing.

4.5 Off Circuit Tap Changing Equipment

The tap change switch shall be three phase, hand operated for simultaneous switching of similar taps on the three phases by operating an external hand wheel.

4.6 Marshalling Box

A metal enclosed, weather, vermin & dust proof marshalling box shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have a degree of protection of IP 55 as per IEC: 60947 Part-1.

4.7 Cable boxes

Whenever cable connections are required, suitable cable boxes shall be provided and shall be air insulated. They shall be of sufficient size to accommodate Purchaser's cables and shall have suitable removable side/top cover to facilitate cable termination and inspection. Cable boxes shall be dust & vermin proof.

5.0 Inspection and Testing

a) The Contractor shall draw up and carry out a comprehensive inspection and testing program during manufacture and commissioning of the transformer. The programme shall be duly approved by the Purchaser.

b) The Contractor shall carryout all routine tests on all the transformers as per relevant standards. Type test report shall be submitted for approval during detail engineering.

6.0 Inspection

6.1 Tank and Accessories

a) Physical and dimensional check of transformer tank and accessories.

b) Crack detection of major strength weld seams by dye penetration test.

6.2 Core

a) Physical inspection and check of quality of varnish, if used.

b) Sample testing of core material for checking specific loss, bend properties, magnestisation, characteristics and thickness.

c) Check on completed core for measurement of iron loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.

d) HV Test

6.3 Insulating Material

a) Sample checks for physical properties of the material

b) Check for dielectric strength

c) Check for the reaction of hot oil on insulating material

6.4 Winding

a) Sample check on winding conductor for mechanical properties and electrical conductivity and on installation covering.

b) Sample check on insulation paper for pH value, Bursting strength, Electric strength.

6.5 Assembled Transformer

a) Check complete transformer against approved outline drawing provision for all fittings, finish etc.

b) Jacking test on all the assembled transformers.

6.6 Oil

All Standard tests in accordance with relevant Standards shall be carried out on oil samples taken from the transformer before and after testing of the transformer.

The contractor shall also prepare a comprehensive inspection and testing programme for all bought out sub-contracted items and shall submit the same to the Purchaser for approval. Such programme shall include the following components:

a) Buchholz Relay
b) Winding temperature Indicator
c) Bushings
d) Marshaling Box
e) Tap changer switch
f) Oil temperature indicator

7.0 Factory Test

7.1 All standard routine tests in accordance with latest issue of IEC: 60076 shall be carried out on each transformer.

7.2 The transformer shall conform to all the type tests in accordance with latest issues of IEC: 60076. The manufacturer shall submit type tests & additional test reports as listed above as already carried out on transformers of identical design for owner's acceptance. In such a case validity of type test reports shall be in line with clause 9.2 of Chapter 2-GTR of technical specifications. Following parameters in general shall be ensured for establishment of identical design as per IEC 60076, Part-V.

a) Same Voltage ratio, KVA rating, vector group & impedance.
b) Same conceptual design of core and winding.
c) Same arrangement and geometrical sequence of the main windings.
d) Same type of winding conductors.
e) Same type of main windings.
f) Absorbed power at short circuit (ie rated power/per unit short circuit impedance) between 30% and 130% of that relating to the reference transformer.
g) Axial forces and winding stresses occurring at short circuit not exceeding 120% of those relating to the reference transformer.
h) Same manufacturing process.
i) Same Clamping and winding support arrangement..

7.3 In addition to all type and routine tests, transformer shall also conform to following additional type tests as per IEC: 60076.

a) Measurement of zero sequence impedance

b) Short circuit test

c) Measurement of acoustic noise level. This shall conform to NEMA standard publication TR-1.

d) Measurement of capacitance and tan delta of transformer winding.

e) Test on oil samples as per IS 60296

7.4 All auxiliary equipment shall be tested as per the relevant IS Test Certificates shall be submitted for bought out items.

7.5 High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

7.6 Tank Tests:

i) Routine Tests: As per IEC: 60076 Part-1 including
ii) Vacuum Tests: As per IEC: 60076 Part-1
iii) Pressure Test: As per IEC: 60076 Part-1

7.7 In addition to the above, the following checks should be carried out at manufacturer's works before despatch for all transformers:

a) Check for interchangeability of components of similar transformers and for mounting dimensions.

b) Check for proper packing and preservation of accessories like radiators, bushings explosion vent, dehydrating breather, Buchholz relay, conservator etc.

c) Check for proper provision of bracings to arrest the movements of core and winding assembly inside the tank.

d) Test for gas tightness and derivation of leakage rate. To ensure adequate reserve gas capacity during transit and storage.

7.8 The Contractor shall submit a detailed inspection and testing programme for field activities, covering areas right from the receipt of material stage upto commissioning stage as per IS : 1886 - Code of practice for installation and maintenance of transformers. The indicative checks and tests are given below.

a) Physical checks on each transformer on receipt at site for any damage or short supply.
b) Tests on oil samples
c) Oil leakage test
d) Physical checks for colour of silica in breather
e) Check for oil level in breather housing, conservator tank, etc.
f) Check for correct operation of all protections and alarms.
g) Insulation Resistance Measurement for Main Winding, control wiring etc.
h) Continuously observe the transformer operation at no load for 24 hours.

8.0 **Fittings**

The following fittings shall be provided with each transformer covered under this specification.

i) Conservator with drain plug and oil filling hole with blanking plate
ii) Plain oil Gauge
iii) Silica gel Breather
iv) Pressure Relief vent

v) Pocket on tank cover for Thermometer
vi) Valves
vii) Earthing Terminals
viii) Rating & Terminal Marking Plates
ix) Lifting Lugs
x) Rollers
xi) Air Release Plug

The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of transformer are deemed to be included.

9.0 Spare Parts

9.1 The list of spares for outdoor type transformers covered under this chapter shall be as specified in Chapter 1- PSR

9.2 In addition, the Bidder shall also recommend optional spare parts and maintenance equipment necessary for three (3) years of successful operation of the equipment. The prices of these shall be indicated in respective schedules and these shall not be considered for the purpose of evaluation.

10.0 Technical Specification

S No	Description	Unit	Parameters
1	Rated Capacity	kVA	315 KVA
2	Rated Voltage		
a)	HV	kV	11
b)	LV	kV	0.400
3	Type of Winding		Two Winding
4	Service		Outdoor
5	No of Phases	No.	Three
6	Frequency	Hz	50
7	Type of Cooling		ONAN
8	Impedance at 75 Deg C	%	0.05
9	Tolerance on Impedance	%	±10
10	Duty		Continuous
11	Overload		IEC:60076-7
12	Max. Temp. Rise over an ambient of 50 Deg C		
a)	Oil (Temperature rise measurement by thermometer)	^{O}C	50

S No	Description	Unit	Parameters
b)	Winding Temperature rise measurement by resistance method)	^{O}C	55
13	Windings		
a)	System Apparent Short circuit level (kA)		As per IEC: 60076-Part 1
b)	Winding Connection		
(i)	HV		Delta
(ii)	LV		Star
14	Vector Group		Dyn11
15	Insulation		Uniform
16	Insulation Level	kVrms	
a)	Power Frequency Test Level		
(i)	HV	kVrms	28
(ii)	LV	kVrms	2
17	Basic Impulse Level		
(i)	HV	kVp	75
(ii)	LV	kVp	-
18	Highest voltage (kV) for each winding	kV	12
19	Method of earthing		Solidly earthed
20	Tap changer		
a)	(i) Tap Change		+5% to -10% in step of 2.5% on HV side
b)	(ii) Tap control		Off Circuit Tap Change Switch
21	HV Bushing		
a)	Rated Voltage	kV	12
b)	Rated current	A	
c)	Basic Impulse Level (kVp)	kVp	75
d)	Wet & Dry Power frequency Withstand Voltage	kVrms	28
e)	Min. Total Creepage Distance	mm	300
f)	Mounting		Tank / Transformer Body
22	**LV & Neutral Bushing**		
a)	Rated Voltage	kV	1.1

S No	Description	Unit	Parameters	
b)	Rated current	A		
c)	Basic Impulse Level (kVp)	kVp	-	-
d)	Wet & Dry Power frequency Withstand Voltage	kVrms	2	
e)	Mounting		Tank / Transformer Body	
23	Terminal Details			
a)	HV		Suitable for 11kV Cable or Over Head Conductor	
b)	LV & Neutral		Cable Box	
24	Min. Clearance in Air	mm		
a)	Ph-Ph (HV/LV)	mm	280/25	
b)	Ph-Earth (HV/LV)	mm	140/25	

CHAPTER 8: FIRE PROTECTION

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TECHNICAL SPECIFICATION FOR

FIRE PROTECTION SYSTEM

1.00.00 **INTENT OF SPECIFICATION**

This section covers the design and performance requirements of the following types of fire protection systems consisting of; (as required)

a. Hydrant System

b. High Velocity Water (H.V.W) Spray System

c. Fire Detection and alarm System

d. Portable Fire Extinguishers

e. Wheel/ Trolley mounted Fire Extinguishers

1.00.01 It is not the intent to completely specify all details of design and construction. Nevertheless, the system design and equipment shall conform in all respects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner. The system design shall also conform to NFPA norms.

1.00.02 The scope of work include complete earthwork (i.e. excavation, backfilling etc.) for the entire buried piping for the system, valve pits and pipe supports for buried, entrenched and overground piping.

1.00.03 The equipment offered shall comply with the relevant latest International Standards **unless specified otherwise**. The Deluge valves, HVW spray nozzles & quartzoid bulb detectors shall have the approval of any of the following agencies;

a. UL of USA.
b. F M of USA
c. LPCB of UK or
d. VDS of Germany,

1.00.04 Ambient temperature for design of all equipment shall be considered as 50°C.

1.00.05 The piping and instruments diagram for Hydrant and HVW spray system for 400kV switchyard is enclosed at Appendix-I. respectively. The successful bidder shall prepare detailed layout and piping drawing based on this drawing and other drawings such as road, drainage, cable trench, switch yard layout, etc. as furnished by the Employer during detailed engineering.

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2.00.00 DESIGN AND CONSTRUCTION

2.01.00 Hydrant System (Not Applicable)

Hydrant system of fire protection essentially consists of a large network of pipe, both under ground and over ground which feeds pressurised water to a number of hydrant valves, indoor (if applicable) as well as outdoor. These hydrant valves are located at strategic locations near buildings, Transformers and Reactors. Hose pipes of suitable length and fitted with standard accessories like branch pipes, nozzles etc., are kept in Hose boxes. In case of emergency, these hoses are coupled to the respective hydrant valves through instantaneous couplings and jet of water is directed on the equipment on fire. Hydrant protection shall be provided for the following in all substations of voltage levels 132kV and above (This is not applicable for extension of existing 220kV and 132kV substations where Hydrant system is not available). At least one hydrant post shall be provided for every 60m of external wall measurement of buildings.

a) Control room building

b) L.T. Transformer area.

c) Fire Fighting pump House.

d) Stores

e) Transformers

f) GIS Building.

g) Auxiliary Building for Indoor Switchyard

2.01.01 A warning plate shall be placed near the hydrant points for the transformers and reactors substations to clearly indicate that water shall be sprayed only after ensuring that the power to the transformer/ reactor which is on fire is switched off and there are no live parts within 20metres of distance from the personnel using the hydrant.

2.02.00. HIGH VELOCITY WATER (H.V.W) SPRAY SYSTEM (Not Applicable)

H.V.W. spray type fire protection essentially consists of a network of projectors and an array of heat detectors around the Transformer/Reactor to be protected. On operation of one or more of heat detectors, Water under pressure is directed to the projector network through a Deluge valve from the pipe network laid for this

system. This shall be provided for transformers and reactors in all 132kV & above substations (This is not applicable for extension of existing 220kV and 132kV substations where HVWS system is not available). Wet detection initiation system shall be employed for automatic operation.

The system shall be designed in such a way that the same can be extended to protect additional Transformer/ Reactor to be installed in future. However, for the purpose of design it shall be assumed that only one Transformer/ Reactor will be on fire. The main header pipe size in the yard shall be 250mmNB (for 400kV switchyard) and 200mmNB(for 220kV & 132kV switchyard). Branch to the equipment (shall not be more than 20metres length) shall be of the same size as of deluge valve.

2.02.01 The Electrical clearance between the Emulsifier system pipe work and live parts of the protected equipment shall not be less than the values given below :

1.	245 kV bushing	2150 mm
2.	145 kV bushing	1300 mm
3.	52 kV bushing	630 mm
4.	36/11 kV bushing	320 mm

2.02.02 System shall be designed in such a way that the Water pressure available at any spray nozzle shall be between 3.5bar and 5.0bar and shall be demonstrated through hydraulic calculations. Water shall be applied at a minimum rate of 10.2 LPM/M^2 of the surface area of the transformer / Reactor including radiator, conservator, oil pipes, bushing turrets, etc. (including bottom surface for transformer). The nozzle arrangement shall ensure direct impingement of water on all exterior surfaces of transformer tank, bushing turrets, conservator and oil pipes, except underneath the transformer, where horizontal spray may be provided.

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2.02.03 **Deluge Valve (Not Applicable)**

Deluge Valve shall be water pressure operated manual reset type. The Deluge valve shall be closed water tight when water pressure in the heat detector pipe work is healthy and the entire pipe work shall be charged with water under pressure upto the inlet of the Deluge valve. On fall of water pressure due to opening of one or more heat detectors, the valve shall open and water shall rush to the spray water network through the open Deluge valve. The valves shall be

manually reset to initial position after completion of operation. Each Deluge Valve shall be provided with a water motor gong which shall sound an alarm when water after passing through the Deluge valve, is tapped through the water motor.

Each Deluge valve shall be provided with a local panel with provision of opening of Deluge valve from local and remote from control room/ remote centre. In addition to this, each valve shall be provided with local operation latch.

Deluge valves of 100mmNB size shall be used if the flow requirement is ≤ 200m^3/hr and 150mmNB size shall be used for flow requirement >200m^3/hr.

Test valves shall simulate the operation of Deluge valves and shall be of quick opening type. The general construction shall conform to requirements under clause no.7.00.00 for piping, valves and specialities.

2.02.04 **High Velocity Spray Nozzles (Projectors) (Not Applicable)**

High velocity spray system shall be designed and installed to discharge water in the form of a conical spray consisting of droplets of water travelling at high velocity, which shall strike the burning surface with sufficient impact to ensure the formation of an emulsion. At the same time the spray shall efficiently cut off oxygen supply and provide sufficient cooling.

2.02.05 Minimum set point of the heat detectors used in the HVW spray system shall be 79ºC. The optimum rating shall, however, be selected by the Bidder, keeping in mind the maximum and minimum temperature attained at site.

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2.03.00 **Fire Detection and alarm System**

This system shall be provided for control room building ,GIS Building,Indoor Switchgear Building and Switchyard panel rooms of substations**.**

2.03.01 Suitable fire detection system using smoke detectors and/or heat detectors shall be provided for the entire building, including corridor and toilets. Fire detectors shall be located at strategic locations in various rooms of the building. Each Switchyard panel room shall be considered a separate zone. Adequate number of extra zones shall be provided for Switchyard panel rooms for future bays identified in Single line diagram of the substation. The operation of any of the fire detectors/ manual call point should result in the following;

1. A visual signal exhibited in the annunciation panels indicating

the area where the fire is detected.

2. An audible alarm sounded in the panel, and
3. An external audible alarm sounded in the building, location of which shall be decided during detailed engineering.
4. If the zone comprises of more than one room, a visual signal shall be exhibited on the outer wall of each room.

2.03.02 Each zone shall be provided with two zone cards in the panel so that system will remain healthy even if one of the cards becomes defective.

2.03.03 Coverage area of each smoke detector shall not be more than 80 m^2 and that of heat detectors shall not be more than 40 m^2. Ionisation type smoke detectors shall be provided in all areas except pantry room where heat detectors shall be provided. If a detector is concealed, a remote visual indication of its operation shall be provided. Manual call points (Break glass Alarm Stations) shall be provided at strategic locations in the control room building. All cabling shall be done through concealed conduits.

2.03.04 Cables used should be exclusively for fire detection and alarm system and shall be 2Cx1.5sq.mm Cu. cables. Un-armoured PVC insulated FR cables conforming to latest IEC / International standards shall be used.

2.04.00 Portable and Wheel/ Trolley mounted Fire Extinguishers

2.04.01 Portable Fire Extinguishers

Adequate number of portable fire extinguishers of pressurised water, dry chemical powder, and Carbon dioxide type shall be provided in suitable locations in control room building and FFPH building as indicated in the drawing. In addition to this one (1) CO2 type fire extinguisher of 4.5kg capacity shall be provided for each Switchyard panel room. These extinguishers will be used during the early phases of fire to prevent its spread and costly damage.

The design, construction & testing of portable fire extinguishers shall meet the requirements as per clause 10.00.00.

2.04.02 Wheel/ Trolley mounted Fire Extinguishers

Wheel/Trolley mounted Mechanical foam type fire extinguishers of 50litre capacity, conforming to latest international standards, shall be provided for the protection of the following:

1. Transformers and reactors in 220kV and 132 kV substations where Hydrant/HVWS system is not available. Two (2) nos. for

each 220kV or 132kV transformer and reactor.

2. LT transformers in all substations. One (1) no. for each LT transformer.

The design, construction & testing of Mechanical foam type 50 litre capacity shall meet the requirements of relevant International Codes and clause 10.00.00 of this specification.

2.05.00 Water Supply System **(Not Applicable)**

For 400kV and above level substations water for hydrant & HVW system shall be supplied by one electrical motor driven pump of rated capacity 410m3/hr. at 70MWC head, with another pump of same capacity , driven by diesel engine, shall be used as standby. Water storage tank with two compartments of adequate capacity shall be provided. Pumps shall work under positive suction head. Annunciations of the hydrant & HVW spray systems shall be provided in fire water pump house and repeated in control room. Provision for sending data to remote control centre shall also be available.

The outdoor piping for the system in general shall be laid above ground on concrete pedestals with proper supporting arrangement. However, at road/rail crossings, in front/access of buildings, places where movement of cranes/vehicles is expected and at any other place where above ground piping is not advisable, the pipes shall be laid underground. Such locations shall be finalised during detailed engineering.

The whole system will be kept pressurised by providing combination of air vessel and jockey pump of 10.8M^3/hr. capacity at 80MWC. The capacity of air vessel shall not be less than 3m^3. Minor leakage will be met by Jockey pump. One additional jockey pump shall be provided as standby. All pumps shall be of horizontal centrifugal type. Pumps and air vessel with all auxiliary equipment will be located in firewater pump house. A pressure relief valve of suitable rating shall be provided in water header to release excess pressure due to atmospheric temperature variations.

Operation of all the pumps shall be automatic and pumps shall be brought into operation at preset pressure. Fire pumps shall only be stopped manually. Manual start/stop provision shall be provided in local control panel.

2.05.01 The general design of the fire fighting pump sets shall meet the requirements under clauses no.5.00.00 for Horizontal centrifugal pumps, no.6.00.00 for Diesel engines and no.12.00.00 for Electrical motors.

2.05.02 Each pump shall be provided with a nameplate indicating suction lift/delivery head, capacity and number of revolutions per minute.

2.05.03 Design, construction, erection, testing and trial operation of piping, valves, strainers, hydrant valves, hoses, nozzles, branch pipes, hose boxes, expansion joints etc. shall conform to the requirements of clause no. 7.00.00.

2.06.00 **Instrumentation and Control System**

2.06.01 All instruments like pressure indicators, differential pressure indicators, pressure switches, level indicators, level switches, temperature indicators, alarms and all other instruments and panels as indicated in the specification and drawings and those needed for safe and efficient operation of the whole system shall be furnished according to the requirements of clause 11.00.00. Pump running/ fails to start signal shall be taken from the pressure switch immediately after the discharge of the pump.

2.06.02 **Control Panel (Not Applicable)**

Power feeder for motors will be from switchgear board located in control building but control supply for all local control panels, annunciation panels, battery charger units, space heaters etc. shall be fed from the AC and DC distribution boards located in pump house. These AC & DC distribution boards will be fed from the switchgears and DCDBs located in control building.

a) Panel for motor driven fire water pump

The panel shall be provided with the following:

1.	TPN switch	1 No.
2.	Auto/manual selection facility	
3.	Start/Stop facility with indication lamp	1 Set
4.	DOL starter with thermal O/L relay	1 Set
5.	Indicating lamp showing power ON	1 Set
6.	Indication lamp with drive ON/OF	1 Set
7.	Indication lamp showing Motor Trip	1 No.

Additional provisions shall be made for controlling the following from the remote control centre:

1. Auto/manual selection facility

2. Start/Stop facility

Main power cable from breaker feeder of main switchboard shall be terminated in this panel and another cable shall emanate from this panel which shall be terminated at motor terminals.

b) Panel for Two nos. Jockey Pump 1No.

The panel shall be provided with the following :

1.	Fuse-switch unit for Jockey pumps	1 Set for each pump
2.	Auto/manual selection facility for eachpump	
3.	Selector switch for selecting either jockey pump	1 No.
4.	D.O.L. starter with overload relay self-resetting type, for all the drives.	1 No. each
5.	Start/stop push button for Jockey Pump with indication lamp with pad-locking arrangements in stop position	1 Set for each pump
6.	Indication lamp for trip indication	1 No. each for pump

Additional provisions shall be made for controlling the following from the remote control centre:

1. Auto/manual selection facility for each pump**.**

a) Panel for 2 Nos. battery charger & Diesel Engine driven fire water pump 1 No.

The panel shall be provided with the following :

1.	Auto/Manual selection facility for Diesel Engine driven pump	1 No.

2.	Start/Stop facility with indication lamp	1 Set
3.	Indicating lamp showing drive ON/OFF	1 Set
4.	D.C. Voltmeter/Ammeter in the battery charger circuit	1 No. each
5.	Battery charger will be as per specification described	1 Set
6.	Selector switch for selecting either of battery chargers for the battery sets.	1 No.
7.	Selector switch for selecting either set of batteries for Diesel engine starting.	1No.
8.	Selector switch for boost charging/Trickle charging of battery set.	1 Set

Additional provisions shall be made for controlling the following from the remote control centre:

1. Manual Start/Stop of Diesel Engine

d) Individual local control panel is to be considered for each transformer/ Reactor deluge system wherever these equipment are envisaged. This panel shall contain push buttons with indicating lamps for spray ON/OFF operation in the valve operation circuit. Push buttons shall be concealed behind glass covers, which shall be broken to operate the buttons. Provision shall be made in the panel for the field signal for the annunciations such as spray ON and fire in the Transformer/Reactor. A signal for spray ON shall also be provided in the control room fire alarm panel for employer's event logger. Remote operation facility to open the Deluge valve from control room/ remote centre shall also be provided.

2.06.03 **Annunciation Panels**

a) Location: Fire Water Pump House

i) Indicating lamps showing power supply "ON".

ii) Annunciation windows complete with buttons. Details are as follows:

Sl.No.	Description	Number
1.	Electric motor driven fire water pump running	1
2.	Electric motor driven fire water pump fails to start	1
3.	Diesel engine driven fire water pump running.	1
4.	Diesel engine driven water pump fails to start	1
5.	Jockey pump-1 running	1
6.	Jockey pump-1 fails to start	1
7.	Jockey pump-2 running	1
8.	Jockey pump-2 fails to start	1
9.	Fire in Transformer/ Reactor	1 for each equipment
10.	Deluge system operating for Transformer/Reactor	1 for each equipment
11.	Header pressure low	1
12.	Fire in smoke detection system zone (Common Fire Signal)	1
13.	Water storage tank water level low	2
14.	High speed diesel tank level low	1
15.	Spare	10

b) **Location: Substation Control Room**

i) Indication lamp showing power supply 'ON'

ii) Provision shall be made in the panel for a signal for spray ON for each Transformer/Reactor for owner's use for event logger.

iii) Each Switchyard panel room shall be considered as separate zone for fire detection and alarm system.

iv) Following annunciations shall be provided.

Sl.No.	Description	Number
1.	Fire in Transformer/ Reactor	1 for each equipment
2.	Diesel engine driven fire water pump in operation	1
3.	Motor driven fire water pump in operation	1
4.	Jockey pump in operation	1
5.	Fire fighting Water storage tank level Low	2
6.	Fire/Fault (zone alarm module)	1+1(duplicate) For each zone as applicable
7.	Spare windows complete in all respect, with relays	10
8.	Spare zone alarm modules	Number of future A/c Kiosks required for the bays identified

c) Each annunciation panel shall be provided with a hooter**.** A hooter in parallel to the hooter in fire panel shall be provided in the security room of substation for alert in case of fire.

d) Indication for fault in respective areas shall also be provided. Each zone alarm module shall exhibit 'FIRE' and 'FAULT' conditions separately.

e) **Provision for sending data to Remote Control Unit for the following**

(i) Fire in Switchyard Panel Room (Switchyard Panel room shall be considered as separate zone for fire detection and alarm system).

(ii) Fire in Transformer/Reactor (1 for each equipment)

(iii) Diesel engine driven fire water pump in operation.

(iv) Motor driven fire water pump in operation

(v) Fire/Fault in Control Room.

(vi) Water Storage tank level (low and very low for each storage tank).

(vii) High Speed Diesel tank level (low & very low)

(viii) AC Mains Supply Healthy/Fail for Main Pump & Jockey Pump

(ix) DC Control Supply Healthy/Fail for Main Pump & Jockey Pump

(x) DC Control Supply Healthy/Fail for Diesel Engine driven pump.

2.06.04 The control and interlock system for the fire protection system shall meet the following requirements:

1. **Electric Motor Driven Fire water Pump (Not Applicable)**

Pump should start automatically when the System header pressure is low.

Pump should be stopped manually only. Pump should also be started manually if required from local control panel.

2. **Diesel Engine Driven Standby Pump(Not Applicable)**

The pump should automatically start under any of the following conditions:

a) System Header pressure low.

b) Electric motor operated fire water pump fails to start.

Pump should be stopped manually only. Pump should also be started manually if required from the local control panel. The battery set which is connected for starting of Diesel engine shall not be subjected to boost charge.

3. **Jockey Pump(Not Applicable)**

It shall be possible to select any one of the Jockey pumps as main and the other as standby. Main Jockey pump shall start automatically when water pressure in header falls below the set value. If the main jockey pump fails to start then the standby should start. Jockey pump shall stop automatically when the pressure is restored to its normal value.

Manual starting/stopping shall be possible from the local control panel.

3.00.00 TESTS

3.01.00 Shop Tests

3.01.01 Shop tests of all major equipment centrifugal pumps, diesel engines, electrical drive motors, piping, valves and specialties, pressure and storage vessels, MCC, electrical panels, controls, instrumentation etc. shall be conducted as specified in various clauses and as per applicable standards/codes.

3.01.02 Shop tests shall include all tests to be carried out at Contractor's works, works of his sub-contractor and at works where raw materials supplied for manufacture of equipment are fabricated. The tests to be carried out shall include but not be limited to the tests described as follows :

a) Materials analysis and testing.

b) Hydrostatic pressure test of all pressure parts, piping, etc.

c) Dimensional and visual check.

d) Balancing test of rotating components.

e) Response of heat/smoke detectors.

f) Performance characteristics of HVW spray nozzles (projectors).

g) Flow rate and operational test on Flow control valves.

h) Operational test of alarm valve (water-motor gang).

i) Calibration tests on instruments and tests on control panel.

j) Destruction/burst tests on 2% or minimum one (1) no. of hoses and portable type fire extinguishers for each type as applicable. Any fraction number shall be counted as next higher integer.

k) Performance test on fire extinguishers as required in the code.

3.01.03 In the absence of any Code/Standard, equipment shall be tested as per mutually agreed procedure between the supplier and the Employer.

3.01.04 A comprehensive visual and functional check for panels would be conducted and will include a thorough check up of panel dimensions, material of construction, panel finish, compliance with tubing and

wiring specifications, quality of workmanship, proper tagging & locations of instruments/accessories. The wiring check shall be complete point to point ring out and check for agreement with installation drawings and equipment vendor prints of the complete system and an inspection of all field connection terminals and levelling.

3.01.05 All test certificates and reports shall be submitted to the Employer for approval.

3.01.06 The Employer's representative shall be given full access to all tests. The manufacturer shall inform the Employer allowing adequate time so that, if the Employer so desires, his representatives can witness the test.

3.02.00 **Pre-commissioning Tests**

3.02.01 **General**

a) All piping and valves, after installation will be tested hydraulically at a pressure of 16kg/cm^2 for a period of 30 minutes to check against leak tightness.

b) All manually operated valves/gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever, to the satisfaction of the Employer.

c) All pumps shall be run with the specified fluid from shut off condition to valve wide open condition. Head developed will be checked from the discharge pressure gauge reading. During the test, the pumps and drives shall run smoothly without any undue vibration, leakage through gland, temperature rise in the bearing parts, noise, flow pulsation etc.

d) All pressure vessels should be tested hydraulically at the specified test pressure, singly or in the system.

e) Painting shall be checked by dry type thickness gauges.

f) Visual check on all structural components, welding, painting etc. and if doubt arises, these will be tested again.

g) All test instruments and equipment shall be furnished by the Contractor to the satisfaction of the Employer.

h) Automatic starting of all the fire pumps by operating the test valves.

i) Automatic operation of the Jockey pump

j) Operation of the Deluge valve by breaking a detector as well as manual and remote operation of the deluge valve.

k) Operation of entire annunciation system.

Replacement of fused/damaged quartzoid bulb detectors during the test shall be responsibility of contractor.

3.02.02 After erection at site, the complete HVW spray protection and hydrant system shall be subject to tests to show satisfactory performance for which detailed procedure shall be submitted for Employer's approval.

Full flow tests with water shall be done for the system piping as a means of checking the nozzle layout, discharge pattern and coverage, any obstructions and determination of relation between design criteria and actual performance, also to ensure against clogging of the smaller piping and the discharge devices by foreign matter carried by the water.

Rigidity of pipe supports shall also be checked during the water flow.

3.02.03 All the detectors installed shall be tested for actuation by bringing a suitable source of heat/smoke near the detector and creating a stream of hot air/ smoke over the detector. The exact procedure of this test shall be detailed out by the Employer to the successful Bidder.

4.00.00 **SPARE PARTS**

The Contractor shall indicate in his scope of supply all the mandatory spares in the relevant schedules. The list of mandatory spares is indicated in ‘Section - Projects’.

5.00.00 **HORIZONTAL CENTRIFUGAL PUMPS (Not Applicable)**

This clause covers the design, performance, manufacturing, construction features and testing of horizontal centrifugal pumps used for the purpose of fire fighting.

5.01.00 The materials of the various components shall conform to the applicable BS/ASTM/DIN Standards.

5.01.01 In case of any contradiction with the aforesaid standards and the stipulations as per the technical specification as specified hereinafter, the stipulations of the technical specification shall prevail.

5.02.00 **General Performance Requirements**

5.02.01 The pump set shall be suitable for continuous operation at any point

within the "Range of operation".

5.02.02 Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off.

5.02.03 Pumps shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of rated head. Range of operation shall be 20% of rated flow to 150% of rated flow.

5.02.04 The pump-motor set shall be designed in such a way that there is no damage due to the reverse flow through the pump which may occur due to any mal-operation of the system.

5.02.05 **Drive Rating**

The drive rating shall not be less than the maximum power requirement at any point within the "Range of Operation" specified.

During starting under reverse flow condition, the motor shall be capable of bringing the pump to rated speed at normal direction with 90% rated voltage at motor terminals.

5.02.06 Pump set along with its drive shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall guided by applicable standards.

5.02.07 The Contractor under this specification shall assume full responsibility in the operation of the pump and drive as one unit.

5.03.00 **Design & Construction**

5.03.01 Pump casing may be axially or radially split. The casing shall be designed to withstand the maximum pressure developed by the pump at the pumping temperature.

5.03.02 Pump casing shall be provided with adequate number of vent and priming connections with valves, unless the pump is made self-venting & priming. Casing drain, as required, shall be provided complete with drain valves.

5.03.03 Under certain conditions, the pump casing nozzles will be subjected to reactions from external piping. Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.

5.03.04 Pump shall preferably be of such construction that it is possible to service the internals of the pump without disturbing suction and discharge piping connections.

5.03.05 **Impeller**

The impeller shall be secured to the shaft and shall be retained

against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft impellers shall be secured to the shaft by an additional locknut or cap screw. All screwed fasteners shall tighten in the direction of normal rotation.

5.03.06 **Wearing Rings**

Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing. Suitable method of locking the wearing ring shall be used.

5.03.07 **Shaft**

Shaft size selected shall take into consideration the critical speed, which shall be at least 20% away from the operating speed. The critical speed shall also be atleast 10% away from runaway speed.

5.03.08 **Shaft Sleeves**

Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft & shaft sleeve and that past the seals/gland.

5.03.09 Shaft sleeves shall be securely fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

5.03.10 **Bearings**

Bearings of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its "Range of Operation" and also at the shut-off condition. The bearing shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

5.03.11 **Stuffing Boxes**

Stuffing box design shall permit replacement of packing without removing any part other than the gland. Stuffing boxes shall be sealed/cooled by the fluid being pumped and necessary piping, fittings, valves, instruments, etc. shall form an integral part of the pump assembly.

5.03.12 **Shaft Couplings**

All shafts shall be connected with adequately sized flexible couplings of suitable design. Necessary guards shall be provided for the couplings.

5.03.13 **Base Plates & Sole Plate**

A common base plate mounting both for the pump and drive shall be furnished.

The base plate shall be of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc. Suitable drain taps and drip lip shall be provided.

5.03.14 Material of Construction

All materials used for pump construction shall be of tested quality. Material of construction of the major parts of the pumps shall be as given below or superior as per relevant latest International standards:

a)	Casing	Casting Grade 17 of BS 1452
b)	Impeller	Bronze Grade LG2-C of BS1400
c)	Wearing ring	Bronze Grade LG2-C of BS1400
d)	Shaft	Mild Steel.
e)	Shaft sleeve	Bronze Grade LG2-C of BS1400
f)	Stuffing box	2.5% Nickel CI Grade 17 of BS 1452
g)	Gland	--- do ---

5.03.15 **Balancing**

All rotating components shall be statically and dynamically balanced at shop.

5.03.16 All the components of pumps of identical parameters supplied under this specification shall be interchangeable.

5.04.00 **Tests and Inspection**

5.04.01 The manufacturer shall conduct all routine tests required to ensure that the equipment furnished conform to the requirements of this specification and are in compliance with the requirements of applicable Codes and Standards. The particulars of the proposed tests and the procedures for the tests shall be submitted to the Employer/Engineer for approval before conducting the tests.

5.04.02 Where stage inspection is to be witnessed by Employer, in addition to above, the Bidder shall submit to the Employer/Engineer at the

beginning of the contract, the detailed PERT-Chart showing the manufacturing programme and indicating the period where Employer or his authorised inspecting agency are required at the shop.

5.04.03 **Material of Construction**

All materials used for pump construction shall be of tested quality. Materials shall be tested as per the relevant standards and test certificates shall be made available to the Employer/Engineer.

5.04.04 Where stage inspection is to be witnessed by Employer, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication, by Employer's Inspector who shall stamp the material. In case mill test certificates for the material are not available, the Contractor shall carry out physical and chemical tests at his own cost from a testing agency approved by the Employer, as per the requirements of specified material standard. The samples for physical and chemical tests shall be drawn up in presence of Employer's inspector who shall also witness the tests.

5.04.05 Shaft shall be subjected to 100% ultrasonic test and machined portion of the impeller shall be subject to 100% DP test. On finished shaft DP test will also be carried out.

5.04.06 **Hydraulic test at shop**

All pressure parts shall be subjected to hydraulic testing at a pressure of 150% of maximum pressure generated by the pump at rated speed or 200% of total dynamic head whichever is higher, for a period not less than one (1) hour.

5.04.07 **Performance test at shop**

Pumps shall be subjected to routine tests to determine the performance of the pumps. These tests shall be conducted in presence of Employer/Engineer's representative as per the requirements of the ASME Power Test Code PTC 8.2/BS- 599/I.S.S., latest edition. Routine tests shall be done on all the pumps.

5.04.08 Performance tests shall be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 150% of rated capacity upto pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point and the two extremities of the Range of operation specified.

5.04.09 Tests shall preferably be conducted alongwith the actual drives being supplied.

5.04.10 The Bidders shall submit in his proposal the facilities available at his works to conduct performance testing. If because of limitations of available facilities, a reduced speed test or model test has to be resorted to establish pump performance, the same has to be highlighted in the offer.

5.04.11 In case of model testing, the stipulations of latest edition of apllicable standards shall be binding. Prototype or model tests, however, shall be conducted with the suction condition identical to the field conditions i.e. sigma values of prototype and model is to be kept same.

5.04.12 Prior to conducting model testing, calculations establishing model parameters, sizes and test procedure will be submitted to Employer/Engineer for approval.

5.04.13 All rotating components of the pumps shall be subjected to static and dynamic balancing tests.

5.04.14 The Employer or his authorised representative shall have full access to all tests. Prior to performance tests, the Contractor shall intimate the Employer allowing adequate time so that if the Employer so desires, his representative can witness the test.

5.04.15 Report and test certificates of the above tests shall be submitted to the Employer/Engineer for approval.

5.04.16 **Pre commissioning tests.**

After installation, pumps offered may be subjected to testing at field also by Employer. If the performances at field are not found to meet the requirement, then the equipment shall be rectified by the Contractor without any extra cost. Prior to performance testing, the procedure for such tests will be mutually agreed between Employer and Contractor. The Contractor shall furnish all necessary instruments, accessories and personnel for testing. Prior to testing, the calibration curves of all instruments and permissible tolerance limit of instruments shall be mutually agreed upon.

6.00.00 **DIESEL ENGINES (Not Applicable)**

This Clause covers the design, performance, manufacturing construction features and testing of compression ignition diesel engines, used primarily for driving centrifugal pumps, used for the purpose of fire fighting.

6.01.00 **Design and Construction**

General

6.01.01 The diesel engine shall be of multicylinder type four-stroke cycle with mechanical (airless) injection, cold starting type.

6.01.02 The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be atleast 20% greater than the requirement at the duty point of pump at rated RPM and in no case, less than the maximum power requirement at any condition of operation of pump.

6.01.03 Reference conditions for rated output of engine shall be as per ISO:3046, part I.

6.01.04 The engine shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

6.01.05 All parts subjected to substantial temperature changes shall be designed and supported to permit free expansion and contraction without resulting in leakage, harmful distortion or misalignment.

6.01.06 **Starting**

The engine shall be capable of both automatic and manual start. The normal mode of starting is automatic but in the event of failure of automatic start or at the discretion of the operator, the engine can be started manually from the LCP.

Since the fire pumping unit driven by the diesel engine is not required to run continuously for long periods and the operation will not be frequent, special features shall be built into the engine to allow it to start within a very short period against full load even if it has remained idle for a considerable period.

6.01.07 If provision for manual start (cranking) is provided, all controls/ mechanisms, which have to be operated during the starting process, shall be within easy reach of the operator.

6.01.08 Automatic cranking shall be effected by a D.C. motor having high starting torque to overcome full engine compression. Starting power will be supplied from either of the two (2) sets of storage batteries. The automatic starting arrangement shall include a 'Repeat Start' feature for 3 attempts. The battery capacity shall be adequate for 3 (three) consecutive starts without recharging with a cold engine under full compression.

6.01.09 The batteries shall be used exclusively for starting the diesel engine and be kept fully charged all the time in position. Arrangement for both trickle and booster charge shall be provided.

Diesel engine shall be provided with two (2) battery charger units of air-cooled design. The charger unit shall be capable of charging one (1) set of battery at a time. Provision shall, however, be made so that any one of the charger units can be utilised for charging either of the two (2) batteries.

6.01.10 For detail design of battery and battery charger, sub- section Electrical may be referred to.

6.01.11 **Governing System:**

The engine shall be fitted with a speed control device, which will control the speed under all conditions of load.

6.01.12 The governor shall offer following features:

a) Engine should be provided with an adjustable governor capable of regulating engine speed within 5% of its rated speed under any condition of load between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.

b) Engine shall be provided with an over speed shut- down device. It shall be arranged to shut-down the engine at a speed approximately 20% above rated engine speed and for manual reset, such that the automatic engine controller will continue to show an over speed signal until the device is manually reset to normal operating position (Vol.II, NFPA, 1978).

6.01.13 The governor shall be suitable for operation without external power supply.

6.01.14 **Fuel System**

The diesel engine will run on High Speed Diesel.

6.01.15 The engine shall be provided with fuel oil tank of 250 litres capacity. The fuel oil tank shall preferably be mounted near the engine. No fuel oil tank will be provided by the Employer.

6.01.16 The fuel oil tank shall be of welded steel constructed to relevant standards for mild steel drums. The outlet of the tank shall be above the inlet of fuel injection pump of the diesel engine to ensure adequate pressure at suction of injection pump.

6.01.17 The fuel oil tank shall be designed in such a way that the sludge and sediment settles down to the tank bottom and is not carried to the injection pump. A small sump shall be provided and fitted with drain plug to take out sludge/sediment and to drain oil. Adequate hand holes (greater than 80 mm size) shall be provided to facilitate maintenance.

6.01.18 Pipeline carrying fuel oil shall be gradually sloped from the tank to the injection pump. Any valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position. A filter shall be incorporated in this pipeline, in addition to other filters in the fuel oil system. Pipe joints shall not be soldered and plastic tubing shall not be used. Reinforced flexible pipes may also be used.

6.01.19 The complete fuel oil system shall be designed to avoid any air pocket in any part of the pipe work, fuel pump, sprayers/injectors, filter system etc. No air relief cock is permitted. However, where air relief is essential, plugs may be used.

6.01.20 A manual fuel pump shall be provided for priming and releasing of air from the fuel pipelines.

6.01.21 **Lubricating Oil System**

Automatic pressure lubrication shall be provided by a pump driven by the crank shaft, taking suction from a sump and delivering pressurised oil through cooler and fine mesh filters to a main supply header fitted in the bed plate casing. High pressure oil shall be supplied to the main and big end bearings, cam-shaft bearings, cam-shaft chain and gear drives, governor, auxiliary drive gears etc. Valve gear shall be lubricated at reduced pressure through a reducing valve and the cams by an oil bath.

6.01.22 **Cooling Water System**

Direct cooling or heat exchanger type cooling system shall be employed for the diesel engine. Water shall be tapped from the fire pump discharge. This water shall be led through duplex strainer, pressure breakdown orifice and then after passing through the engine, the water at the outlet shall be taken directly to the sump through an elevated funnel.

6.02.00 **Testing & Inspection**

6.02.01 The manufacturer shall conduct all tests required, to ensure that the equipment furnished conforms to the requirement of this sub-section and in compliance with requirements of applicable codes. The particulars of the proposed tests and the procedure for the tests shall be submitted to the Employer for approval before conducting the tests.

6.02.02 At manufacturer's works, tests shall be carried out during and after completion of manufacture of different component/parts and the assembly as applicable. Following tests shall be conducted.

6.02.03 Material analysis and testing.

6.02.04 Hydrostatic pressure testing of all pressure parts.

6.02.05 Static and dynamic balance tests of rotating parts at applicable over-speed and determination of vibration level.

6.02.06 MPI/DPT on machined parts of piston and cylinder.

6.02.07 Ultrasonic testing of crankshaft and connecting rod after heat treatment.

6.02.08 Dimensional check of close tolerance components like piston, cylinder bore etc.

6.02.09 Calibration tests of all fuel pumps, injectors, standard orifices, nozzles, instruments etc.

6.02.10 Over speed test of the assembly at 120% of rated speed.

6.02.11 Power run test.

6.02.12 Performance test of the diesel engine to determine its torque, power and specific fuel consumption as function of shaft speed. Performance test of the engine shall be carried for 12 hours out of which 1 hour at full load and one hour at 110% overload.

6.02.13 Measurement of vibration & noise.

(i) Measurement of vibration

The vibration shall be measured during full load test as well as during the overload test and limit shall be 100 microns.

(ii) Measurement of noise level

The equivalent 'A' weighted sound level measured at a distance of 1.5 M above floor level in elevation and 1.0 M horizontally from the base of the equipment, expressed in dB to a reference of 0.0002 microbar shall not exceed 93 dBA.

Above tests for vibration shall be repeated at site as pre-commissioning tests.

6.02.14 Adjustment of speed governor as per BS:5514.

6.02.15 Diesel engine shall be subjected to routine tests as per BS:5514.

7.00.00 PIPING, VALVES AND SPECIALITIES

This clause covers the design, manufacture, shop testing, erection, testing and commissioning of piping, valves and specialities.

7.02.00 Scope

The piping system which shall include but not be limited to the following:

7.02.01 Plain run of piping, bends, elbows, tees, branches, laterals, crosses, reducing unions, couplings, caps, expansion joints, flanges, blank flanges, thrust blocks, anchors, hangers, supports, saddles, shoes, vibration dampeners, sampling connections, hume pipes etc.

7.02.02 Gaskets, ring joints, backing rings, jointing material etc. as required. Also all welding electrodes and welding consumables including special ones, if any.

7.02.03 Instrument tapping connections, stubs etc.

7.02.04 Gate and globe valves to start/stop and regulate flow and swing check valves for one directional flow.

7.02.05 Basket strainers and Y-type strainers

7.02.06 Bolts, nuts, fasteners as required for interconnecting piping, valves

and fittings as well as for terminal points. For pipe connections into Owner's R.C.C. works, Bidder will furnish all inserts.

7.02.07 Painting, anti-corrosive coatings etc. of pipes and equipment.

Adequate number of air release valves shall be provided at the highest points in the piping system to vent any trapped air in the system.

7.03.00 **Design**

7.03.01 Material of construction of various pipes shall be as follows :

(a) **Buried Pipes**

Mild steel black pipes as per ASTM A53 medium grade suitably lagged on the outside to prevent soil corrosion, as specified elsewhere.

(b) **Overground Pipes normally full of water**

Mild steel black pipes as per ASTM A53 medium grade.

(c) Overground pipes normally empty, but periodic charge of water and for detector line for HVW System**.**

Mild steel galvanised pipes as per ASTM A53 medium grade.

7.03.02 All fittings to be used in connection with steel pipe lines upto a size of 80 mm shall be as per ASTM A53 Mild steel tubulars and other wrought steel pipe fittings, Heavy grade. Fittings with sizes above 80 mm upto 150 mm shall be fabricated from ASTM A53 Heavy grade pipes or steel plates having thickness not less than those of ASTM A53 Heavy grade pipes. Fittings with sizes above 150 mm shall be fabricated as per ASTM A53 standard. All fitting used in GI piping shall be threaded type. Welding shall not be permitted on GI piping.

7.03.03 Pipe sizes shall not be less than the sizes indicated in the attached drawings.

7.03.04 For steel pipeline, welded construction should be adopted unless specified otherwise.

7.03.06 All piping system shall be capable of withstanding the maximum pressure arising from any condition of operation and testing including water hammer effects.

7.03.09 Gate/sluice valve shall be used for isolation of flow in pipe lines and **construction** shall be as per BS 5150. Valves shall be of rising spindle type and of PN 1.6 class

7.03.10 Gate Valves shall be provided with the following :

(a) Hand wheel.

(b) Position indicator.

(c) Locking facility (where necessary).

7.03.11 Gate valves shall be provided with back seating bush to facilitate gland removal during full open condition.

7.03.12 Globe valves shall be provided with contoured plug to facilitate regulation and control of flow. All other requirements should generally follow those of gate valve.

7.03.13 Non-return valves shall be swing check type. Valves will have a permanent "arrow" inscription on its body to indicate direction of flow of the fluid.

7.03.14 Whenever any valve is found to be so located that it cannot be approached manually from the nearest floor/gallery/platform hand wheel with floor stand or chain operator shall be provided for the same.

7.03.15 Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections.

7.03.14 **Basket Strainer**

a) Basket strainers shall be of 30mesh and have the following materials of construction :

Body: Fabricated mild steel (Tested Quality). Strainer Wires: stainless steel (AISI : 316), 30 SWG, suitably reinforced.

b) Inside of basket body shall be protected by two (2) coats of heavy duty bitumastic paint.

c) Strainers shall be Simplex design. Suitable vent and drain connections with valves shall be provided.

d) Screen open area shall be at least 4 times pipe cross sectional area at inlet.

e) Pressure drop across strainer in clean condition shall not exceed 1.5 MWC at 410M3/hr (for 765kV/400kV substations) and 1 MWC at 273M3/hr flow (for 220kV & 132kV substations). Pressure drop test report of strainer of same design shall be furnished.

7.03.15 **Y-type On-line Strainer**

Body shall be constructed of mild steel (tested quality). Strainer wires shall be of stainless steel AISI:316, 30 SWG, 30 mesh.

Blowing arrangement shall be provided with removable plug at the outlet. Screen open area shall be atleast 4 times pipe cross-

sectional area at inlet.

Pressure drop test report of strainer of same design shall be furnished.

7.03.16 **Hydrant Valve (Outdoor) and Indoor Hydrant Valves (Internal Landing Valves).**

The general arrangement of outdoor stand post assembly, consisting of a column pipe and a hydrant valve with a quick coupling end shall be as per TAC requirement.

Materials of construction shall be as follows or superior :

a)	Column pipe	M.S. ASTM A53 med. grade.
b)	Hydrant Valve	
i)	Body	Stainless steel**.**
ii)	Trim	Leaded tin bronze.
iii)	Hand Wheel	Cast Iron.
iv)	Washer, gasket, etc.	Rubber.
v)	Quick coupling connection	Leaded tin bronze
vi)	Spring	Phosphor Bronze.
vii)	Cap and chain	Leaded tin bronze

The general design of hydrant valve shall conform to relevant latest international standards.

7.03.17 **Hoses, Nozzles, Branch pipes and Hose boxes**

(a) Hose pipes shall be of reinforced rubber-lined canvas construction with nominal size of 63 MM (2 1/2") and lengths of 15 metre or 7.5 metre, as indicated elsewhere.

(b) Hosepipes shall be capable of withstanding an internal water pressure of not less than 35**.7** kg/cm^2 without bursting. It must also withstand a working pressure of 8.5 kg/cm^2 without undue leakage or sweating.

(c) Each hose shall be fitted with instantaneous spring lock type couplings at both ends. Hose shall be fixed to the coupling ends by copper rivets and the joint shall be reinforced by 1.5 mm galvanised mild steel wires and leather bands.

(d) Branch pipes shall be constructed of copper and have rings of leaded tin bronze at both ends. One end of the branch pipe will receive the quick coupling while the nozzles will be fixed to the other end.

(e) Nozzles shall be constructed of leaded tin bronze.

(f) Suitable spanners of approved design shall be provided in adequate numbers for easy assembly and dismantling of various components like branch pipes, nozzles, quick coupling ends etc.

(g) Hose pipes fitted with quick coupling ends, branch pipes, nozzles spanner etc. will be kept in a hose box, which will be located near point of use.

(h) All instantaneous couplings, as mentioned under clause Nos.3.03.19, 3.03.20 and 3.03.21 above shall be of identical design (both male and female) so that any one can be interchanged with another. One male, female combination shall get locked in by mere pushing of the two halves together but will provide leak tightness at a pressure of 8 kg/cm2 of water. Designs employing screwing or turning to have engagement shall not be accepted.

7.04.00 **Fabrication & Erection**

7.04.01 The contractor shall fabricate all the pipe work strictly in accordance with the related approved drawings.

7.04.02 **End Preparation**

(a) For steel pipes, end preparation for butt welding shall be done by machining.

(b) Socket weld end preparation shall be sawing/machining.

(c) For tees, laterals, mitre bends, and other irregular details cutting templates shall be used for accurate cut.

7.04.03 **Pipe Joints**

(a) In general, pipes having sizes over 25 mm shall be joined by butt welding. Pipes having 25 mm size or less shall be joined by socket welding/screwed connections. Galvanised pipes of all sizes shall have screwed joints. No welding shall be permitted on GI pipes. Screwed joints shall have tapered threads and shall be assured of leak tightness without using any sealing compound.

(b) Flanged joints shall be used for connections to vessels, equipment, flanged valves and also on suitable straight lengths of pipe line of strategic points to facilitate erection and subsequent maintenance work.

7.04.04 **Overground Piping**

(a) Piping to be laid overground shall be supported on pipe rack/supports. Rack/supports details shall have to be approved by Employer/Engineer.

(b) Surface of overground pipes shall be thoroughly cleaned of mill scale, rust etc. by wire brushing. Thereafter one (1) coat of **red oxide primer** shall be applied. Finally two (2) coats of synthetic enamel paint of approved colour shall be applied.

7.04.05 **Buried Pipe Lines**

(a) Pipes to be buried underground shall be provided with protection against soil corrosion by coating and wrapping with two coats of coal tar hot enamel paint and two wraps of reinforced fibre glass tissue. The total thickness of coating and wrapping shall not be less than 3 mm. Alternatively corrosion resistant tapes can also be used for protection of pipes against corrosion.

(b) For Coating and wrapping, holiday testing to be performed inline with latest ASTM standards.

(c) Buried pipelines shall be laid with the top of pipe one meter below ground level.

(d) At site, during erection, all coated and wrapped pipes shall be tested with an approved Holiday detector equipment with a positive signalling device to indicate any fault hole breaks or conductive particle in the protective coating.

7.05.00 **General Instruction for Piping Design and Construction**

7.05.01 While erecting field run pipes, the contractor shall check, the accessibility of valves, instrument tapping points, and maintain minimum headroom requirement and other necessary clearance from the adjoining work areas.

7.05.02 Modification of prefabricated pipes, if any, shall have to be carried out by the contractor at no extra charge to the Employer.

7.05.03 **Welding**

(i) Welding shall be done by qualified welders only.

(ii) Before welding, the ends shall be cleaned by wire brushing, filing or machine grinding. Each weld-run shall be cleaned of slag before the next run is deposited.

(iii) Welding at any joint shall be completed uninterrupted. If this cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling.

(iv) Welding shall be done by manual oxyacetylene or manual shielded metal arc process. Automatic or semi-automatic welding processes may be done only with the specific approval of Employer/ Consultant.

(v) As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.

(vi) No backing ring shall be used for circumferential butt welds.

(vii) Welding carried out in ambient temperature of 5°C or below shall be heat-treated.

(viii) Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form part of final welding, they shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints.

Electrodes size for tack welding shall be selected depending upon the root opening.

(ix) Tacks should be equally spaced as follows **:**

for 65 NB and smaller pipes : 2 tacks

for 80 NB to 300 NB pipes : 4 tacks

for 350 NB and larger pipes : 6 tacks

(x) Root run shall be made with respective electrodes/filler wires. The size of the electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG) and should preferably be 2.3 mm (12 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.

(xi) Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxyacetylene welding is recommended.

(xii) The root run of butt joints shall be such as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.

(xiii) On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping.

(xiv) Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG. (3.25 mm). At least two runs shall be made on socket weld joints.

7.06.00 **Tests at Works**

7.06.01 **Pipes**

(i) Mechanical and chemical tests shall be performed as required in the codes/standards.

(ii) All pipes shall be subjected to hydrostatic tests as required in the codes/standards.

(iii) 10% spot Radiography test on welds of buried pipes shall be carried out as per ASME VIII.

7.06.02 **Valves**

(i) Mechanical and chemical tests shall be conducted on materials of the valve as required in the codes/standards.

(ii) All valves shall be tested hydrostatically for the seat as well as required in the code/standards for a period of ten minutes.

(iii) Air test shall be conducted to detect seat leakage.

(iv) Visual check on the valve and simple operational test in which the valve will be operated thrice from full open to full close condition.

(v) No repair work on CI valve body, bonnet or wedge shall be allowed.

7.06.03 **Strainers**

(i) Mechanical and chemical tests shall be conducted on materials of the strainer.

(ii) Strainers shall be subjected to a hydrostatic test pressure of 1.5 times the design pressure or 10 kg/cm2g whichever is higher for a period of one hour.

7.06.04 **Hydrant valves and Indoor Hydrant Valves (Internal Landing Valves)**

(i) The stand post assembly along with the hydrant valve (valve being open and outlet closed) shall be pressure tested at a hydrostatic pressure of 21 kg/cm2g to detect any leakage through defects of casting.

(ii) Flow test shall be conducted on the hydrant valves at a pressure of 7 kg/cm2g and the flow through the valve shall not be less than 900 litres/min.

(iii) Leak tightness test of the valve seat shall be conducted at a

hydrostatic test pressure of 14 kg/cm2g.

7.06.05 **Hoses, Nozzles, Branch Pipes and Hose Boxes**

Reinforced rubber-lined canvas hoses shall be tested hydrostatically. Following tests shall be included as per relevant latest International standard.

a) Hydrostatic proof pressure test at 21.4 kgf/cm2g

b) Internal diameter

The branch pipe, coupling and nozzles shall be subjected to a hydrostatic test pressure of 21 kg/cm2g for a period of $2^1/_2$ minutes and shall not show any sign of leakage or sweating.

Dimensional checks shall be made on the hose boxes and nozzle spanners.

8.00.00 **AIR VESSELS**

8.01.00 Air vessels shall be designed and fabricated of mild steel as class-II vessels as per BS 5500 for a pressure of 14kg/cm^2 and shall be minimum 3 m^3 capacity.

8.02.00 Inside surface of the tank shall be protected by anti-corrosive paints/coatings/linings as required.

8.03.00 Outside surfaces of the vessels shall be provided with one (1) coat of red lead primer with two (2) coats of synthetic enamel paint of approved colour and characteristics.

8.04.00 **Tests & Inspection**

8.04.01 Air vessels shall be hydraulically tested at 21kg/cm2 for a period not less than one (1) hour.

8.04.02 All materials used for fabrication shall be of tested quality and test certificates shall be made available to the Owner.

8.04.03 Welding procedure and Welder's qualification tests will be carried out as per relevant lenternational Standard.

8.04.04 NDE tests, which will include 100% Radiography on longitudinal seams and spot Radiography for circumferential seams, for pressure vessel will be carried out.

9.00.00 **HEAT DETECTORS/FIRE DETECTORS AND SPRAY NOZZLES**

9.00.01 **Intent of Specification**

This specification lays down the requirements of the smoke detectors, heat detectors and spray nozzles for use in various sub-systems of the fire protection system.

9.00.02 **Codes and Standards**

All equipment supplied shall conform to internationally accepted codes and standards.

9.01.00 **Heat Detectors**, **Quartzoid bulb type.** (Used in HVW spray system)

a) Heat detectors shall be of any approved and tested type. Fusible chemical pellet type heat detectors are however not acceptable.

b) Temperature rating of the heat detector shall be selected by the Bidder taking into consideration the environment in which the detectors shall operate. Minimum set point shall, however, be 79oC.

c) Heat detectors shall be guaranteed to function properly without any maintenance work for a period of not less than twenty five (25) years.

d) The heat detectors shall be mounted on a pipe network charged with water at suitable pressure. On receipt of heat from fire, the heat detector will release the water pressure from the network. This drop in water pressure will actuate the Deluge valve.

9.02.00 **HVW Spray Nozzles (Projectors)**

High velocity water spray system shall be designed and installed to discharge water in the form of a conical spray consisting of droplets of water travelling at high velocity which shall strike the burning surface with sufficient impact to ensure the formation of an emulsion. At the same time the spray shall efficiently cut off oxygen supply and provide sufficient cooling. Integral non-ferrous strainers shall be provided in the projectors ahead of the orifice to arrest higher size particle, which are not allowed to pass through the projectors.

9.03.00 **Fire Detectors (Used in fire detection and alarm system)**

9.03.01 Fire detectors shall be approved by FOC-London or similar international authorities.

9.03.02 Both smoke and heat type fire detectors shall be used. Bidder shall clearly indicate the mode of operation of detectors in his proposal.

9.03.03 The set point shall be selected after giving due consideration for ventilating air velocity and cable insulation.

9.03.04 Fire detectors shall be equipped with an integral L.E.D. so that it shall be possible to know which of the detectors has been operated. The detectors, which are to be placed in the space above the false ceiling or in the floor void shall not have the response indicators on the body but shall be provided with remote response indicators.

9.03.05 Approval from competent authority shall be made available for ionisation type smoke detectors. All required accessories shall also be included in the scope of supply.

9.03.06 Fire detectors shall be guaranteed to function properly without any maintenance work for a period of not less than ten (10) years.

10.00.00 PORTABLE AND WHEEL/ TROLLEY MOUNTED FIRE EXTINGUISHERS

10.00.01 This specification lays down the requirement regarding fire extinguishers of following types :

Portable fire extinguishers.

a) Pressurised water type.

b) Dry chemical powder type

c) Carbon Dioxide type

Wheel/ Trolley mounted fire extinguishers.

a) Mechanical foam type

10.00.02 All the extinguishers offered by the Bidder shall be of reputed make.

10.01.00 Design and Construction

10.01.01 All the portable extinguishers shall be of freestanding type and shall be capable of discharging freely and completely in upright position.

10.01.02 Each extinguisher shall have the instructions for operating the extinguishers on its body itself.

10.01.03 All extinguishers shall be supplied with initial charge and accessories as required.

10.01.04 Portable type extinguishers shall be provided with suitable clamps for mounting on walls or columns.

10.01.05 All extinguishers shall be painted with durable enamel paint of fire red colour conforming to relevant International Standards.

10.01.06 Pressurisation of water type fire extinguishers shall either be done by compressed air or by using gas cartridge. Both constant air pressure and the gas pressure type shall conform to their latest relevant International standards.

10.01.07 Dry chemical powder type portable extinguisher shall conform to its latest relevant International standards.

10.01.08 Carbon Dioxide type portable extinguisher and Carbon Dioxide type trolley mounted extinguisher shall conform to their latest relevant International standards.

10.01.09 Wheel/ trolley mounted fire extinguishers of 50 litre capacity Mechanical foam type shall conform to its **latest relevant International standards.**

10.02.00 **Tests and Inspection**

10.02.01 A performance demonstration test at site of five (5) percent or one (1) number whichever is higher, of the extinguishers shall be carried out by the Contractor. All consumable and replaceable items require for this test would be supplied by the Contractor without any extra cost to Employer.

10.02.02 Performance testing of extinguisher shall be in line of applicable International Standards. In case where no International Standard is applicable for a particular type of extinguisher, the method of testing shall be mutually discussed and agreed to before placement of order for the extinguishers.

10.03.00 **Painting**

Each fire extinguisher shall be painted with durable enamel paint of fire red colour conforming to relevant International Standards.

11.00.00 **INSTRUMENTS**

11.00.01 **Intent of Specification**

The requirements given in the sub-section shall be applicable to all the instruments being furnished under this specification.

11.00.02 All field mounted instruments shall be weather and dust tight, suitable for use under ambient conditions prevalent in the subject plant. All field mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance can be achieved.

11.01.00 **Local Instruments**

Pressure/ Differential Gauges & Switches.

11.01.01 The pressure sensing elements shall be continuous 'C' bourdon type.

11.01.02 The sensing elements for all gauges/switches shall be properly aged and factory tested to remove all residual stresses. They shall be able to withstand atleast twice the full scale pressure/vacuum without any damage or permanent deformation.

11.01.03 For all instruments, connection between the pressure sensing element and socket shall be braced or hard soldered.

11.01.04 Gauges shall be of 150 mm diameter dial with die-cast aluminium, stoved enamel black finish case, aluminium screwed ring and clear plastic crystal cover glass. Upper range pointer limit stop for all gauges shall be provided.

11.01.05 All gauges shall be with stainless steel bourdon having rotary geared stainless steel movements.

11.01.06 Weatherproof type construction shall be provided for all gauges. This type of construction shall be fully dust tight, drip tight, weather resistant and splash proof with anti-corrosive painting conforming to NEMA- 4.

11.01.07 All gauges shall have micrometer type zero adjuster.

11.01.08 Neoprene safety diaphragm shall be provided on the back of the instruments casing for pressure gauges of ranges 0-10 Kg/cm^2 and above.

11.01.09 Scales shall be concentric, white with black lettering and shall be in metric units.

11.01.10 Accuracy shall be $\pm$ 1.0 percent of full range or better.

11.01.11 Scale range shall be selected so that normal process pressure is approximately 75 percent of full scale reading. For pressure gauges and pressure switches, the range shall not be less than 0 -16 Kg/cm^2

11.01.12 All gauges shall have 1/2 inch NPT bottom connection.

11.01.13 All instruments shall conform to their **latest relevant International standards.**

11.01.14 All instruments shall be provided with 3 way gauge isolation valve or cock. Union nut, nipple and tail pipe shall be provided wherever required.

11.01.15 Switch element contact shall have two (2) NO and two (2) NC contacts rated for 240 Volts, 10 Amperes A.C. or 220 Volts, 5 Amperes D.C. Actuation set point shall be adjustable throughout the range. ON-OFF differential (difference between switch actuation and de-actuation pressures) shall be adjustable. Adjustable range shall be suitable for switch application.

11.01.16 Switches shall be sealed diaphragm, piston actuated type with snap action switch element. Diaphragm shall be of 316 SS.

11.01.18 Necessary accessories shall be furnished.

11.02.00 **Timers**

11.02.01 The timers shall be electro-mechanical type with adjustable delay on

pick-up or reset as required.

11.02.02 Each timer shall have two pairs of contacts in required combination of NO and NC.

11.03.00 **Level Gauges/Indicator/Switches**

11.03.01 **Level Gauges**

i) Gauge glasses shall be used for local level indication wherever shown in the flow diagram.

ii) Gauge glasses, in general, shall be flag glass type with bolted cover. Body and cover material shall be of carbon steel with rubber lining.

iii) Level coverage shall be in accordance with operating requirements. Maximum length of a single gauge glass shall not exceed 1.4 M. Should a larger gauge glass be required, multiple gauges of preferably equal length shall be used with 50 mm overlap in visibility.

iv) Reflex type gauge glasses shall be used for colourless liquids and transparent type gauge glasses shall be used for all liquids having colour.

v) Each gauge glass shall be complete with a pair of offset valves. Valves shall have union bonnet, female union level connection, flanged tank connection, and vent and drain plug.

vi) Offset valves shall have corrosion resistant ball-check to prevent fluid loss in the event of gauge glass breakage. Valve body shall have a working pressure of 200 percent of the maximum static pressure at the maximum process fluid temperature. Valve body materials shall be of carbon steel with rubber lining.

11.03.02 **Level Indicators**

i) Float type mechanical level gauges with linear scale type indicator shall be offered for measuring level of tanks wherever shown in the flow diagram.

ii) AISI-316 stainless steel float, guide rope and tape shall be used. Housing shall be of mild steel painted with anti-corrosive painting.

iii) The scale indicator shall be provided at a suitable height for ease of reading.

iv) Accuracy shall be + 1% of scale range or better.

11.03.03 **Level Switches**

i) Level switches shall be of ball float operated magnetic type

complete with cage.

ii) Materials of construction shall be suitable for process and ambient conditions. The float material shall be AISI-316 stainless steel.

iii) Actuating switches shall be either hermetically sealed mercury type or snap acting micro-switches. Actuation set point shall be adjustable. ON-OFF differential (difference between switch actuation and de-actuation levels) shall be adjustable. Adjustable range shall be suitable for switch application. All switches shall be repeatable within + 1.0 percent of liquid level change required to activate switch. Contacts shall be rated for 50 watts resistive at 240 V A.C. Number of contacts shall be two NO and two NC for each level switch.

11.04.00 **Solenoid Valves**

11.04.01 The body of the valves shall be Forged brass or stainless steel.

11.04.02 The coil shall be continuous duty, epoxy moulded type Class-F, suitable for high temperature operation.

11.04.03 The enclosure shall be watertight, dust-tight and shall conform to NEMA-4 Standard.

11.04.04 The valves shall be suitable for mounting in any position.

11.05.00 **Switches, Lamps, Meters Etc.**

All electrical components on the panel namely push buttons, switches, lamps, meters etc. shall meet the requirements of sub-section Electrical enclosed with the specification.

11.06.00 All local instruments shall be inspected by Employer/Consultant as per the agreed quality plan.

11.07.00 Makes of control panel and local instruments, accessories shall be as per Employer's approval.

12.00.00 **ELECTRIC MOTORS (Not Applicable)**

12.01.00 **General**

12.01.01 This clause covers the requirements of three phase squirrel cage induction motors and single-phase induction motors.

12.01.02 The motors to be furnished, erected and commissioned as covered under this specification shall be engineered, designed, manufactured, erected, tested as per the requirements specified herein. These requirements shall however be read along with the requirements of the respective driven equipment being supplied under the specification of which this specification forms a part.

12.01.03 The motor supplied under this specification shall conform to the standards specified in GTR.

12.01.04 Terminal point for all motors supplied under this specification shall be at the respective terminal boxes.

12.01.05 Materials and components not specifically stated in this specification but are necessary for satisfactory operation of the motor shall be deemed to be included in the scope of supply of this specification.

12.01.06 Notwithstanding anything stated in this motor specification, the motor has to satisfy the requirement of the mechanical system during normal and abnormal conditions. For this the motor manufacturer has to co-ordinate with the mechanical equipment supplier and shall ensure that the motor being offered meets the requirements.

12.02.00 **Codes & Standards**

12.02.21 The design, manufacture, installation and performance of motors shall conform to the provisions of latest Electricity Act and Electricity Rules. Nothing in these specifications shall be construed to relieve the Contractor of his responsibility.

12.02.22 In case of contradiction between this specifications and IEC, the stipulations of this specification shall be treated as applicable.

12.02.23 National Electrical code for hazardous location and relevant NEMA standard shall also be applicable for motors located in hazardous location.

12.03.00 **Design Features (Not Applicable)**

12.03.01 **Rating and type**

(i) The induction motors shall be of squirrel cage type unless specified otherwise.

(ii) The motors shall be suitable for continuous duty in the specified ambient temperature.

(iii) The MCR KW rating of the motors for 50^{o}C ambient shall not be less than the power requirement imposed at the motor shaft by the driven equipment under the most onerous operation conditions as defined elsewhere, when the supply frequency is 51.5 Hz (and the motor is running at 103% of its rated speed).

(iv) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously in the system having the following particulars :

a) Rated terminal voltage

From 0.2 to 200 KW 400V (3 Phase, solidly earthed)

Below 0.2 KW 230 V (1 Phase, solidly earthed)

Variation in voltage ± 6%.

b) Frequency 50 Hz ± 3%.

c) Any combination of (a) & (b)

12.03.02 Enclosure

Motors to be installed outdoor and semi-outdoor shall have hose proof enclosure equivalent to IP-55. For motors to be installed indoor, the enclosure shall be dust proof equivalent to IP-54.

12.03.03 **Cooling method**

Motors shall be TEFC (totally enclosed fan cooled) type.

12.03.04 **Starting requirements (Not Applicable)**

(i) **Induction motor**

a) All induction motors shall be suitable for full voltage direct on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

b) Motors shall be capable of withstanding the electro-dynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The starting current of the motor at rated voltage shall not exceed six (6) times the rated full load current subject to tolerance as given in IEC 60034.

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage condition specified under Clause 12.03.01 (iv) (a) shall be capable of withstanding at least two successive starts with coasting to rest between starts and motor initially at the rated load operating temperature. The motors shall also be suitable for three equally spread starts per hour, the motor initially at a temperature not exceeding the rated operating temperature.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than the starting time with the driven equipment at minimum permissible voltage (clause 12.03.04 (i) (a) by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement the Bidder shall offer centrifugal type speed switch mounted on the motor shaft

which shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

12.03.05 **Running requirements**

(i) When the motors are operating at extreme condition of voltage and frequency given under clause no.12.03.01 (iv) the maximum permissible temperature rise over the ambient temperature of 50^{o}C shall be within the limits specified in IEC 60034 after adjustment due to increase ambient temperature specified herein.

(ii) The double amplitude of motor vibration shall be within the limits specified in IEC/International standards. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

(iii) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

(iv) Induction motors shall be so designed as to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage during fast changeover of buses. The necessary feature incorporated in the design to comply with this requirement shall be clearly indicated in the proposal.

(v) Motors shall be capable of developing the rated full load torque even when the supply voltage drops to 70% of rated voltage. Such operation is envisaged for a period of one second. The pull out torque of the induction motors to meet this requirement shall not be less than 205% of full load torque.

(vi) The motors shall be capable of withstanding for 10 seconds without stalling or abrupt change in speed (under gradual increase of torque) an excess torque of 60 percent of their rated torque, the voltage and frequency being maintained at their rated value.

(vii) Guaranteed performance of the motors shall be met with tolerances specified in respective standards.

12.04.00 **Construction Features**

12.04.01 **Stator**

(i) **Stator frame**

The stator frames and all external parts of the motors shall be rigid fabricated steel or of casting. They shall be suitably annealed to eliminate any residual stresses introduced during the process of

fabrication and machining.

(ii) **Stator core**

The stator laminations shall be made from suitable grade magnetic sheet steel varnished on both sides. They shall be pressed and clamped adequately to reduce the core and teeth vibration to minimum.

(iii) **Insulation and winding**

All insulated winding conductor shall be of copper. The overall motor winding insulation for all 400 volts motors shall be of epoxy thermosetting type i.e., class 'F' but limited to class-B operating from temperature rise consideration. Other motors may be of conventional class-B type. The windings shall be suitable for successful operation in hot, humid, tropical climate with the ambient temperature of 50oC.

12.04.02 **Rotor**

(i) Rotors shall be so designed as to keep the combined critical speed with the driven equipment away from the running speed by atleast 20%.

(ii) Rotors shall also be designed to withstand 120% of the rated speed for 2 minutes in either direction of rotation.

12.04.03 **Terminal box leads**

(i) For motors of 400 Volts and below a single terminal box may be provided for power and accessories leads.

(ii) Terminal boxes shall be of weatherproof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame.

(iii) Terminal box shall be suitable for top and bottom entry of cables.

(iv) Unless otherwise approved, the terminal box shall be capable of being turned through 360o in steps in 90o.

(v) The terminals shall be complete with all accessories for connecting external cables. They shall be designed for the current carrying capacity and shall ensure ample phase to phase to ground clearances.

(vi) Suitable tinned brass compression type cable glands and cable lugs shall be supplied by the Contractor to match Employer's cable.

(vii) Terminal box for single core cable shall be of non- magnetic

material.

(viii) Marking of all terminals shall be in accordance with IEC / International standard..

12.04.04 **Rating Plates**

(i) Rating plates shall be provided for all motors giving the details as called for in IEC 60034 (for three phase squirrel cage induction motors).

(ii) In addition to above, the rating plate shall indicate the following :

a) Temperature rise in oC under normal working conditions.

b) Phase sequence corresponding to the direction of rotation for the application.

c) Bearing identification number (in case of ball/ roller bearing) and recommended lubricants.

12.04.05 **Other Constructional Features**

(i) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of Employer's earthing conductor to be specified to the successful Bidder.

(ii) Motor weighing more than 25 kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

12.05.00 **Paint and Finish**

12.05.01 Motor external parts shall be finished and painted to produce a neat and durable surface, which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all sharp edges and scales removed and treated with one coat of primer and two coats of grey enamel paint.

12.05.02 Motor fans shall also be painted to withstand corrosion.

12.05.03 All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plated.

12.05.04 Current carrying fasteners shall be either of stainless steel or high tensile brass.

12.06.00 **Tests at Manufacturers Works**

12.06.01 Motors shall be subject to routine tests in accordance with IEC 60034.

12.06.02 In addition, the following tests shall also be carried out :

a) 20% over speed test for 2 minutes on all rotors.

b) Measurement of vibration.

c) Measurement of noise level.

d) Phase sequence and polarity checks relative to mechanical rotation.

12.06.03 **Tests after installation at site**

(i) After installation and commissioning at site, the motors alongwith the driven equipment shall be subject to tests to ascertain their conformity with the requirement of this specification and those of the driven equipment specification and the performance data quoted by the Bidder.

(ii) In case of non-conformity of the motor with these specifications and performance requirement, the Engineer may at his discretion reject or ask for necessary rectification/replacement as detailed in general Terms and Conditions of Contract (GCC) Volume-I.

13.00.00 **BATTERY & BATTERY CHARGERS (Not Applicable)**

This clause covers the design, performance, manufacturing, construction features and testing of Battery and Battery charger used primarily for starting the diesel engine driving the fire water pumps. Battery Chargers shall be housed in Diesel Engine Panel.

13.01.00 **General Information**

13.01.01 The equipment specified hereinafter are required for starting the diesel engines and other operation of the plant as required.

13.01.02 For each diesel engine there shall be two (2) sets of Battery and two (2) sets of Battery Charger.

13.01.03 The D.C. voltage shall be obtained normally after necessary rectification by battery charger. The Battery Charging system shall be capable of meeting the following requirements :

13.01.04 Float charging the Battery.

13.01.05 Boost Charging the Battery.

13.01.06 The battery shall be large enough to crank the engine **3** times without charging in between and without getting drained to an extent which will affect its life.

13.01.07 The Bidder shall indicate the battery voltage and battery capacity in Ampere- Hour at ten (10) hour discharge rate. The battery voltage at any time during operation shall not be less than the minimum voltage

required for operation of the D.C. loads.

13.02.00 **General Design**

The Battery shall be located indoor

13.02.01 **Battery**

(i) The cells shall be lead-acid type. The Battery shall be automotive type.

(ii) The cells shall be sealed in type with anti-splash type vent plug.

(iii) The cell terminal posts shall be provided with connector bolts and nuts, effectively coated with lead to prevent corrosion. Lead or lead coated copper connectors shall be furnished to connect up cells of battery set.

(iv) Positive and Negative terminal posts shall be clearly and indelibly marked for easy identification.

(v) The electrolyte shall be of battery grade Sulphuric Acid. Water for storage batteries conforming to relevant standards shall be used in the preparation of the electrolyte.

13.02.02 **Battery Charger**

(i) The Bidder shall furnish the battery charging scheme complete with all necessary accessories such as transformers, switches, fuses, starters, contactors, diodes, ammeters, voltmeters and other devices as required for trouble free operation. All devices and equipment shall conform to relevant International Standard or shall be Superior to it.

(ii) The scheme of the battery charger shall be such that the battery can be charged automatically as well as manually.

(iii) The boost charger shall have sufficient capacity to restore a fully discharged Battery to a state of full charge in eight (8) hours with some spare margin over maximum charging rate. Suitable provision shall be kept so that, for a particular engine, any of the two (2) charger units can be used for charging any of the two (2) batteries.

(iv) The instruments, switches and lamps shall be flush/semi-flush mounted on the front panel. Name plate of approved type shall be provided for each of these equipment.

(v) The panel shall be complete with internal wiring and input-output terminal block. Terminal blocks shall be clip on type of suitable rating. All equipment and wire terminals shall be identified by symbols corresponding to applicable schematic/wiring diagram.

(vi) Space heaters of adequate capacity shall be provided to prevent moisture condensation in the panel.

13.03.00 **Testing**

13.03.01 The Battery Charger shall also be subjected to the following tests at manufacturer's works as per IEC 60146.

13.03.02 Insulation test.

13.03.03 Connection checking.

13.03.04 Measurement of voltage regulation.

13.03.05 Auxiliary of devices.

13.03.06 Alternating current measurement.

13.03.07 Performance test.

13.03.08 Temperature rise test.

13.03.09 Following acceptance tests shall be carried out in batteries as per IEC/International standard.

a) Marking and packing

b) Verification of dimensions

c) Test for capacity

d) Test for voltage during discharge

Battery and battery charger shall be checked for auto charging and providing sufficient power for three consecutive starting kicks to diesel engine within five minutes with A.C. supply switched off.

14.00.00 **CONTROL & ANNUNCIATION PANELS**

14.01.00 **Intent of Specification**

The following requirement shall be applicable to the control and annunciation panels furnished under these specifications.

14.02.00 **General Information**

14.02.01 The equipment specified herein are required for controlling, metering, monitoring and indication of electrical systems of the plant offered.

14.02.02 The selection and design of all the equipment shall be so as to ensure reliable and safe operation of the plant and shall be subjected

to approval by the Employer.

14.02.03 The reference ambient temperature outside the panel shall be taken as 50oC and relative humidity 100%.

14.03.00 **Equipment to be Furnished**

Control & annunciation panels shall be furnished complete with all accessories and wiring for safe and trouble free operation of the plant. Details are included in sub-section General.

14.04.00 **Constructional Details**

14.04.01 The panel frames shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.5 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary.

14.04.02 Panels shall be of free standing type and shall be provided with hinged door with locking arrangement. The access doors, cutest and covers shall be equipped with neoprene/synthetic rubber gaskets (conforming to IEC 60149) all around and the latches sufficiently strong to hold them in alignment when closed. The panels to be installed outdoor or semi outdoor shall have a degree of protection of IP:55 and those installed indoor shall have a degree of protection of IP:52 as per IEC 60947.

14.04.03 If a panel consists of a number of panels, each panel should be mounted side by side and bolted together to form a compact unit, when two panels meet, the joints shall be smooth, close fittings and un-obstructive.

14.04.04 Removable eye bolt or lifting lugs shall be provided on all panels to facilitate easy lifting.

14.04.05 The heights of all operating equipment on the panel shall be between 800 mm to 1600 mm from the finished floor level. The proper supporting arrangement shall be provided by the Contractor.

14.04.06 Cable entries to the panel may be from bottom or top. The cable entry required will be intimated to the successful Bidder. A suitable removable gland plate of 3 mm thick shall be mounted not less than 200 mm above the floor level.

14.04.07 All equipment mounted on the front face of the panels shall be flush or semi-flush type. All equipment shall be so located that their terminal and adjustment are readily accessible for inspection or maintenance and their removal and replacement can be done without interruption of service to other equipment. The contractor shall submit the panel general arrangement drawings clearly bringing out internal mounting details, dimensions of equipment, clearance between the equipment and the edges of the panel, for approval.

14.05.00 **Name Plates and Labels**

14.05.01 Each panel shall be provided with prominent, engraved identification plates for all front mounted equipment. Panel identification name plate shall be provided at front and rear as required.

14.05.02 All name plates shall be of non-rusting metal or 3 ply lamicold, with white engraved lettering on black background. Inscription and lettering sizes shall be subjected to Employer's approval.

14.05.03 Suitable plastic sticker labels shall be provided for easy identification of all equipment located inside the panel. These labels shall be positioned so as to be clearly visible and shall give the device number, as mentioned in the wiring drawings.

14.06.00 **AC/DC Power Supply**

14.06.02 The Employer will provide one feeder each for AC and DC to the panel. The Contractor shall make for his own arrangements for providing these power supplies to different panels.

14.06.02 The Contractor shall provide suitable isolating switch fuse unit in the control panel for receiving the above incoming AC and DC supplies. Fuse and link shall be provided for isolating of individual circuit without disturbing other circuits.

14.07.00 **Wiring**

14.07.01 All inter panel wiring and connections between panels (if there is group of panels) including all bus wiring for AC & DC supplies shall be provided by the Contractor.

14.07.02 All internal wiring shall be carried out with 1100 V grade, single core, 1.5 square mm or larger stranded copper wires having colour-coded PVC insulation. CT circuits shall be wired with 2.5 square mm copper wires, otherwise similar to the above.

14.07.03 Extra-flexible wire shall be used for wiring to devices mounted on moving parts such as doors.

14.07.04 Spare contacts of auxiliary relays, timers and switches shall be wired out to the terminal blocks as required by the Employer/Engineer at the time of detailed engineering.

14.08.00 **Terminal Blocks**

14.08.01 Terminal Blocks shall be of 650V grade, rated for 10 Amps and in one-piece moulding. It shall be complete with insulating barriers, clip-on-type terminals, and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be similar to 'Elmex-Standard' type terminals.

14.08.02 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal block.

14.08.03 The terminal blocks shall have at least 20% spare terminals.

14.09.00 **Grounding**

A continuous copper bus 25 x 3 mm size shall be provided along the bottom of the panel structure. It shall run continuously throughout the length of the panel and shall have provision at both ends for connection to the station grounding grid (25 x 6 mm MS Flat).

14.10.00 **Space Heater and Lighting**

14.10.01 Space heaters shall be provided in the panels for preventing harmful moisture condensation.

14.10.02 The space heaters shall be suitable for continuous operation on 230V AC, 50 Hz, single phase supply and shall be automatically controlled by thermostat. Necessary isolating switches and fuses shall also be provided.

14.10.03 Free standing panel shall have a 230V AC, plug point and a fluorescent light operated by door switch.

14.11.00 **Control and Selector Switches**

14.11.01 Control and selector switches shall be of rotary type, with escutcheon plates clearly marked to show the function and positions.

14.11.02 Control/selector switches shall be spring return or stay put type as per the requirements. Handles of control/selector switches shall be black in colour. Shape and type of handles shall be to the approval of the Employer.

14.11.03 The contact ratings shall be at least the following :

i)	Make and carry continuously	10 Amp.
ii)	Breaking current at 240V DC	1Amp. (Inductive)
iii)	Breaking current at 240V DC	5 Amp. at 0.3 p.f. lagging

14.12.00 **Push Buttons**

14.12.01 Push buttons shall be spring return, push to actuate type and rated to continuously carry and break 10A at 230V AC and 0.5A (Inductive) at 220V DC. The push buttons shall have at least 1 NO and 1 NC contact. All contact faces shall be of silver or silver alloy.

14.12.02 All push buttons shall be provided with integral escutcheon plates marked with its function.

14.12.03 The colour of buttons shall be as follows :

Green For motor START, Breaker CLOSE, Valve/ damper OPEN.

Red For motor TRIP, Breaker OPEN, Valve/ damper CLOSE.

Black For all annunciation functions, overload reset and miscellaneous.

14.12.04 Red push buttons shall always be located to the left of green push buttons. In case of clinker grinder etc. the push buttons would be black-red-green from left to right.

14.13.00 **Indicating Lamps**

14.13.01 Indicating lamps shall be of the panel mounting, filament type and of low-watt consumption. Lamps shall be provided with series resistors preferably built-in- the lamps assembly. The lamps shall have escutcheon plates marked with its function, wherever necessary.

14.13.02 Lamp shall have translucent lamp covers of the following colours :

Red for motor OFF, Valve/damper OPEN, Breaker CLOSED.

Green for motor ON, Valve/damper CLOSED, Breaker OPEN.

White for motor AUTO-TRIP.

Blue for all healthy conditions (e.g. control supply, lub oil pressure and also for spring charged).

Amber for all ALARM conditions (e.g. pressure low, over load and also for 'service' and 'Test' position indication).

14.13.03 Bulbs and lamps covers shall be easily replaceable from the front of the panel.

14.13.04 Indicating lamps should be located directly above the associated push button/control switches. Red lamps shall variably be located to the right of the green lamp. In case a white lamp is also provided, it shall be placed between the red and green lamps. Blue and amber lamps should normally be located above the red and green lamps.

14.14.00 **Fuses**

14.14.01 All fuses shall be of HRC cartridge plug-in-type and shall be of suitable rating, depending upon circuit requirements.

14.14.02 All fuses shall be mounted on fuse carriers, which shall be mounted on fuse-bases.

14.15.00 **Contactors**

14.15.01 Contactors shall be of air break, electromagnetic type rated as per requirement.

14.15.02 Operating coils of AC contactors shall be of 230V AC or 220V DC as

required. AC contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The Contactor shall not drop out at 70% of the rated voltage.

14.15.03 DC contactors shall have a coil voltage of 220V DC and shall be suitable for satisfactory continuous operation at 80% to 110% of the rated voltage.

14.16.00 **Relays and Timers**

14.16.01 All auxiliary relays & timers shall be of proven design and of reputed make. Contacts of relays and timers shall be of solid silver or silver cadmium oxide or solid silver faced. Timers shall have the provision to adjust the delay on pick-up or reset as required.

14.16.02 All relays and timers shall have at least two NO and two NC contacts.

14.16.03 All relays and timers shall be suitable for 230V AC and 220V DC as required. DC relays shall operate satisfactorily between 70% to 110% and AC relays shall be suitable for voltage variation between 80% to 110%.

14.17.00 **Indication Instruments**

14.17.01 All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales and shall have an accuracy class of 2.0 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

14.17.02 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment removing or dismantling the instruments.

14.17.03 All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.

14.17.04 Ammeters provided on motor feeders shall have a compressed scale at the upper current region to cover the starting current.

14.18.00 **Annunciation System**

14.18.01 The annunciation system shall be complete with all necessary relays, flashers and other accessories required for the proper operation of the equipment and shall be completely solid state. The control circuit shall be mounted on plug-in type glass epoxy printed circuit boards. Audible alarms for the system shall be mounted inside the panel. One set of acknowledge, test and reset push buttons shall be mounted on the panel.

14.18.02 Indications shall be engraved on Acrylic inscription plate window and shall be visible clearly when the indication lamp is lighted (black

letters on white background). Each window shall be provided with two lamps.

14.18.03 Audible hooter shall sound when a trouble contact operates and shall continue to sound until the acknowledge button is pressed. In addition to the hooters provided on annunciation panels, a hooter shall be provided outside FFPH which shall sound in any fire alarm condition.

14.18.04 Indication lamps shall flash when trouble contact operates and shall continue flashing until acknowledge button is pressed.

14.18.05 After acknowledge button is pressed, the hooter and flashing shall stop but the indication lamp shall remain lighted.

14.18.06 After trouble is cleared indication lamps shall be ready and shall go off only when reset.

14.18.07 Silencing the hooter in conjunction with one trouble contact shall not stop and hooter sounding if another trouble contact operates.

14.18.08 When test button is pressed, all lamps shall flash and hooter shall sound.

14.18.09 Annunciator systems shall operate on 220V DC Systems.

14.18.10 The annunciation system shall include alarm for AC control system failure (working on DC supply), DC supply failure (working on AC supply) and test facilities for these alarms.

14.18.11 List of annunciations required on the panels has been listed elsewhere. The Contractor shall also provide additional annunciations if desired by the Employer/Engineer during Vendor drawing review stage and for such additional annunciations no extra charges shall be claimed by the Contractor, if the number of such additions are within 10% of the number stipulated in this specification.

14.18.12 20% spare windows shall be provided on the panel.

14.19.00 **Painting**

14.19.01 **Painting procedure adopted shall conform to requirements given in GTR**. The paint thickness shall not be less than **60** microns. Finished parts shall be coated by peelable compound by spraying method to protect the finished surface from scratches, grease, dirt and oily spots during testing, transportation handling and erection.

14.20.00 **Tests**

14.20.01 Following tests/inspection shall be carried out by the Contractor in the presence of Employer's representative :

(A) Factory Tests

1. Compliance with approved drawings, data and specification.
2. Visual check for workmanship.
3. Wiring continuity and functional checks.
4. Calibration of instruments, relays and metres wherever required by inspector.
5. HV test
6. Insulation resistance measurement before and after HV test.

(B) Inspection/Testing at site :

1. IR test before and after HV test
2. HV Test
3. Functional Testing.

(C)

1. The Fire detection and annunciation panel shall be subjected to functional tests.
2. The Annunciation System shall be routine tested